The FOUNDRY

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Strive for Strength in Malleable

Company Which Formerly Made Railroad Castings Successfully Engages in Automobile Work — Malleable Castings Weighing Nearly 900 Pounds Have Been Made — Light Work Now the Rule

BY H. E. DILLER

SOME years ago the great bulk of work made in malleable iron foundries was castings for railroad and agricultural work. These two classes still make up a goodly proportion of the production of malleable iron foundries, but for the past 15 years many malleable shops have been adding to their various lines of railroad and agricultural malleables, the ever-increasing line of motor-car castings. To some of the malleable companies, this new line of work appealed more strongly because of the long and steady orders which made it attractive to both molders and coremakers, as well as to the various shop departments. While some of the foundries were almost entirely devoted to the fabrication of railroad castings, many of them found it necessary to take on other lines of work in order to maintain their organizations and to keep their workmen employed at times when railroad buying became slack. As the most promising in the way of tonnage, motor castings gave the best indication of permanency. Among the malleable iron foundries which entered upon the manufacture of automobile castings is the Rockford Malleable Iron Works, Rockford, Ill.

The new fields for malleable have also extended to the lines of heavy gray-iron and later steel castings. Frequently, the Rockford foundry receives orders for such heavy castings. One of these castings which weighs 205 pounds is shown in Fig. 1 and another weighing 889 pounds is illustrated in Fig. 2. These castings are examples which prove that heavy castings can be successfully made of malleable iron.

The heavier of the two castings measures 60 inches in length and has walls as much as 3 to 4 inches thick. An analysis of the metal showed, silicon, 0.90; sulphur, 0.075; phosphorus, 0.170; manganese, 0.26, and carbon, 2.35 per cent in the white iron. The cores were set with a crane and the mold was also poured from a ladle carried by a crane, instead of by hand or bull ladles as is the usual method of pouring iron

FIG. 1—ONE OF THE CASTINGS MADE WEIGHS 205 POUNDS

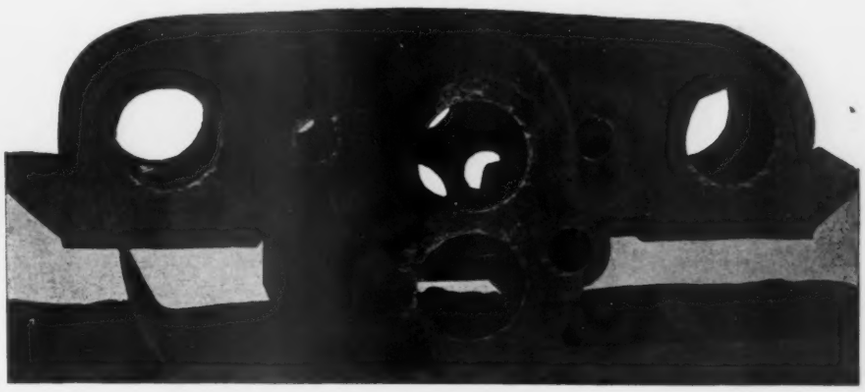


FIG. 2—THIS CASTING WEIGHS 889 POUNDS AND A CRANE WAS REQUIRED FOR POURING AND HANDLING IT—THE WALLS ARE FOUR INCHES THICK AT SOME SECTIONS

FIG. 3—A VIEW OF A PORTION OF THE FOUNDRY ILLUSTRATING THE METHOD OF CARRYING CASTINGS TO THE CLEANING ROOM

FIG. 4—ANNEALING POTS ARE CAST ON A FLOOR PERMANENTLY ARRANGED—NOTE THE STEEL PARTITIONS IN THE FOREGROUND

in the majority of malleable foundries. The pouring gate was in the center of the mold and two large risers were placed at opposite ends of the casting. The gate and risers weighed 250 pounds. After pouring, the casting was allowed to cool in the mold without being disturbed.

The buildings of the Rockford Malleable Iron Works foundry are arranged in the shape of the letter U. In front of the head of one side of the U are the offices. The pattern shop and chemical laboratory are between the offices and the melting and molding department which forms the other leg of the U. Castings after shaking out are sent to the cleaning room located at the base

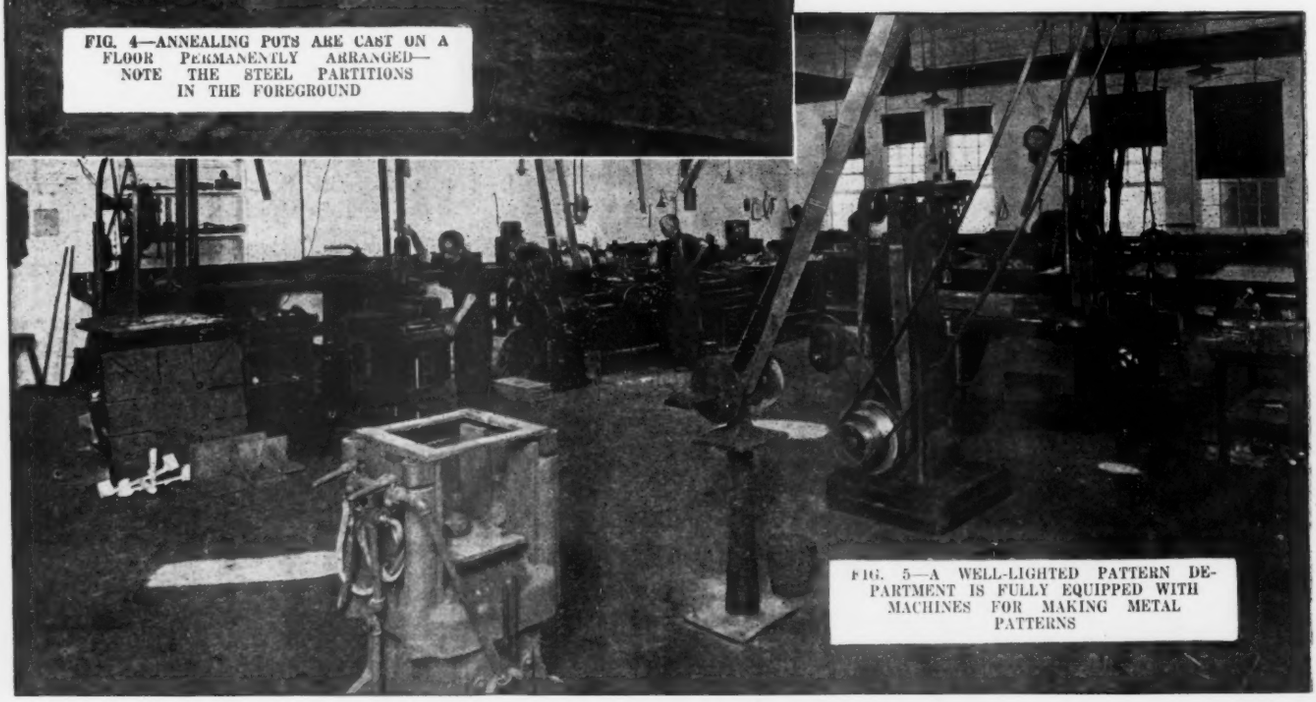


FIG. 5—A WELL-LIGHTED PATTERN DEPARTMENT IS FULLY EQUIPPED WITH MACHINES FOR MAKING METAL PATTERNS

of the U adjacent to the annealing room which occupies a portion of the second leg of the U. After coming through the anneal the castings are sent to the finished cleaning room and thence to the shipping room, both of which are situated in a straight line with the annealing room. By this arrangement castings move forward in a continuous line from the time they are poured until loaded into freight cars for shipping.

Work in a foundry is greatly affected by the quality and kind of patterns used. Realizing this the company has installed a complete and fully equipped pattern shop with all the machinery necessary for making and repairing metal patterns. A view of this shop showing the different easily recognized machines is shown in Fig. 5.

Most of the work handled is molded on machines. Jar-ram, rollover and stripping-plate machines made by the Arcade Mfg. Co., Freeport, Ill., Henry E. Pridmore, Chicago, and the International Molding Machine Co., Chicago, are used according to the style and size of pattern. The molding floors are arranged on both sides of each of two aisles which run lengthwise through the foundry.

Handling Light Castings

One of these aisles may be seen in Fig. 3. This illustration also shows one of the monorails which extend over each aisle. After the castings are shaken out they are placed in buckets hung on a monorail and sent to the cleaning room at the end of the foundry. Each bucket will hold from 500 to 750 pounds, depending upon the size and shape of the castings. As one man can push three loaded buckets, 1500 to 2200 pounds of castings are handled by one laborer. The buckets are unloaded by tilting them on the trunnions, which can be seen in the illustration, allowing the castings to slide into the tumbling barrels or upon the floor. These trunnions extend out from the bucket far enough so that they may also be used as handles to the buckets.

As may be seen at *A*, Fig. 3, concrete troughs are located every 40 feet along the aisle. These troughs receive the overflow from bubbling drinking fountains, *B*, placed at intervals, and act as reservoirs from which the molders can dip water for wetting the sand.

Three 25-ton air furnaces for melting the iron are placed at intervals between the two aisles, extending across the foundry from one aisle to the other. The relative position of one of the furnaces may be seen in Fig. 3, while Fig. 7 gives a more detailed view of another one of the furnaces. This view shows the hood and stack above the firing doors for carrying off the heat and making conditions more comfortable for the fireman. All of the furnaces are the bung type and are charged, partly by removing the bungs beginning at the top blast pipes and extending past the middle of the furnace and then dumping the metal in from buckets lifted by the hand-controlled crane which travels over the furnace, and partly with peales operated on the roller seen at *A*, Fig. 7.

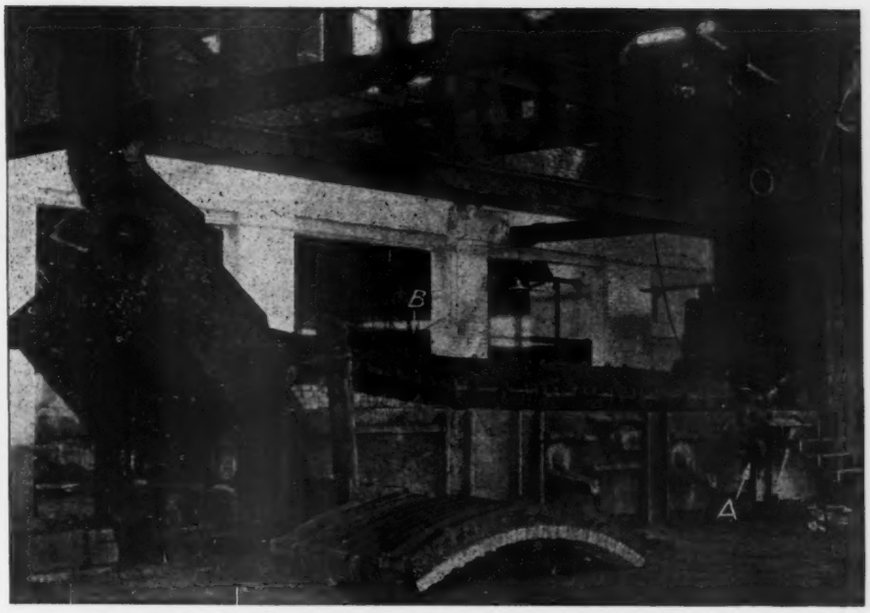


FIG. 7—THREE COAL-FIRED AIR FURNACES ARE OPERATED—METAL IS CHARGED FROM THE TOP AFTER THE BUNGS ARE REMOVED

Over Oxidation Avoided

Beside the natural draft obtained from the stack, a forced draft of 5 ounces is supplied under the fire box and from the top of the furnace through the pipes at *B*, Fig. 7. The top blast is shut off as soon as pouring begins in order to avoid excessive oxidation. The records of heats show an average melting loss of 8 per cent.

In order to secure information regarding the quality of the iron, test pieces are taken when the heat is about half tapped. A sample 1¼ inches wide by 2 inches long and 1 inch deep is cast and sent to the company laboratory for chemical analysis. While these samples are white iron and therefore quite hard, little trouble is experienced in drilling the bars to obtain small particles for the chemist. A one-inch twist drill is used on a low-speed drill press.

Three more samples are taken at the same time for tensile test. These are cast in the form of the standard malle-

FIG. 6—UNLOADING COAL IS FACILITATED BY BRINGING THE CARS IN ON AN ELEVATED TRACK

able test bar of the American Society for Testing Materials. One of them is sent to the laboratory of the American Malleable Castings association, Albany, N. Y., for test. The other two bars are held until a report is received of the test of the first bar. If the first bar proves defective the remaining two bars are sent for test and both of these must pass the requirements of the Malleable Castings association or the certificate of quality is not given to the company for that period of time in which the bars were made. A description of the Malleable Castings association system of issuing certificates of quality to its members was printed in THE FOUNDRY, Oct. 1, page 692.

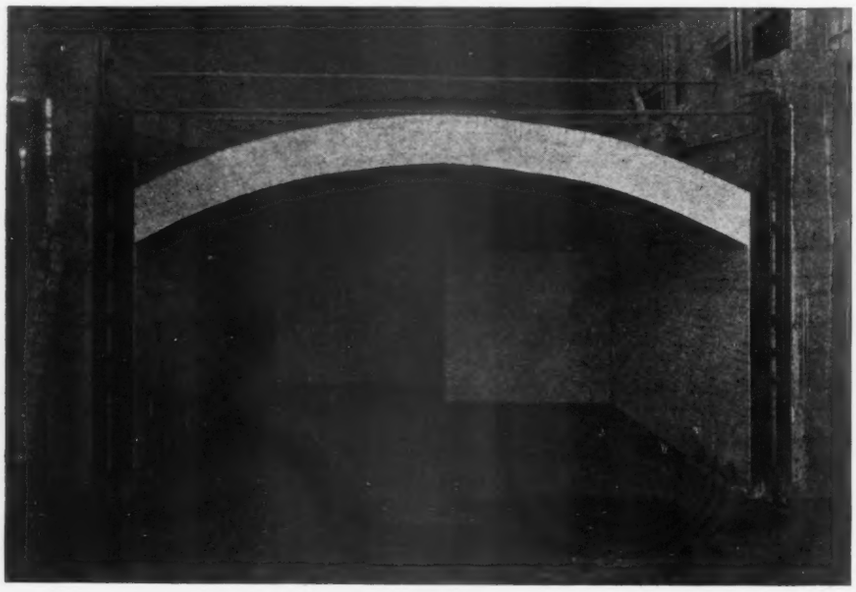


FIG. 8—THE ANNEALING FURNACES ARE FIRED FROM THE REAR AND THE BURNT GASES ARE DISCHARGED THROUGH THE PORTS AT THE FRONT SIDES

The average composition of iron used for the general run of castings is, silicon, 0.85; sulphur, 0.040; phosphorus, 0.170; manganese, 0.26, with 2.50 per cent total carbon in the hard iron. Some of the carbon is burned out of the iron in the anneal, the percentage depending to a large extent upon the thickness of the casting. The tensile strength of the metal averages about 50,000 pounds per square inch while the elongation in 2 inches is usually more than 10 per cent. For quite a long time no bar has tested below 47,000 pounds per square inch or 7.5 per cent elongation in 2 inches as demanded by the American Malleable Castings association.

Molding Annealing Pots

One of the necessary evils in a malleable foundry is the burning of annealing pots which must constantly be replaced. Their renewal is an order which can be put on continuous production and the Rockford company have arranged for molding pots expeditiously. Fig. 5 shows the floor devoted to this work. Two rows of permanent beds have been made in the floor of the foundry. The center wall between the rows and some of the partitions between the molds can be seen in the center foreground. The metal pattern is handled by a chain block on a light travelling I-beam. No copes are used, and the mold is poured through pouring cups from a ladle carried on a two-wheeled truck.

After the castings pass through the hard cleaning room they are taken to the long annealing room situated at right angles to the cleaning room and parallel to the molding department. In this department there are 18 annealing furnaces each of which will hold an average of 25 tons of castings. Fourteen of the furnaces are built in a line on one side of the room while four more have been placed on the opposite side of the room. A view of a portion of the long row of furnaces is shown in Fig. 9. In the foreground is a pile of the packing used. This is made up of mill scale with which a portion of cast-iron turnings is mixed. The quantity of turnings added is rather indefinite, as they are put in to prevent the scale from sticking to the castings and are added from time to time as the appearance of the scale and castings indicates a need of them. Occasionally, also, the scale is sifted through a No. 8 screen to separate the dust.

FIG. 9—THE GREATER PORTION OF THE ANNEALING FURNACES ARE ARRANGED IN A SINGLE ROW

Coal Not Tested

The annealing ovens are coal fired. Fourth-vein Indiana coal is used. This is obtained from selected mines and tests in the past have shown that the coal is so regular in composition that analyses of it are no longer needed. The same is true of the coal purchased for the melting furnaces which comes from the district in eastern Kentucky. The annealing furnace coal contains approximately 1 per cent of sulphur while the coal used for melting does not average much over one-half that amount.

Coal is brought to the storage yard on an elevated track as shown in Fig. 6. The melting furnace coal is stored at both ends of the yard and separated from the annealing coal, which is kept in the center, by two concrete walls. One of these walls may be seen in the illustration. Side-tilt cars are used to take the coal to the foundry. A turntable shifts the cars from the main track to another laid at right angles to it and leading to the melting furnaces on one side and to the annealing department on the other.

Coal is brought in behind the anneal-

ing ovens, each of which has one firing box. A view of the firing wall inside the oven is shown in Fig. 8. This illustration also shows the hole in the back wall for the thermocouple of the pyrometer, one of which is installed in every oven. Each couple is connected to one of the two 16-point indicating pyrometer instruments supplied by the Brown Instrument Co., Philadelphia. The thermocouple on each oven is put through the rear wall in a protective tube and then the hole is looted up with fireclay. The couple does not extend into the oven but the end of the couple is flush with the inside wall.

The temperature in the annealing ovens is run at 1500 degrees Fahr. Thirty-six hours are required to get the oven up to this temperature after which the heat is held at 1500 degrees for 72 hours. The oven is then allowed to cool for 36 hours and on the seventh day after the anneal is started the oven is dumped. Of course, it must be remembered that the temperature recorded is that of the inside of the oven wall and not the temperature of the castings. Were the thermocouple allowed to protrude into the oven a higher temperature might be recorded.

From the annealing ovens the castings are sent to the cleaning and finishing room. Five sandblast barrels and one table are used for cleaning the castings.

Some castings which must be finished accurately to shape are put in a die under a drop hammer and straightened in the finishing room. This operation is made quickly as only one or, at the most, two blows of the hammer are required for each casting. Two of the hammers are shown in Fig. 10 with a pile of automobile castings which have been straightened lying at the side of each hammer. The shipping room, which is next to the finishing room, is so arranged that casting may be loaded upon five cars at one time, from a platform extending along the railroad track.

FIG. 10—CASTINGS ARE STRAIGHTENED ON DIES UNDER DROP HAMMERS—THIS OPERATION IS PERFORMED BY ONE OR TWO BLOWS

Difficulties Experienced in Machining Malleable

By H. E. Diller

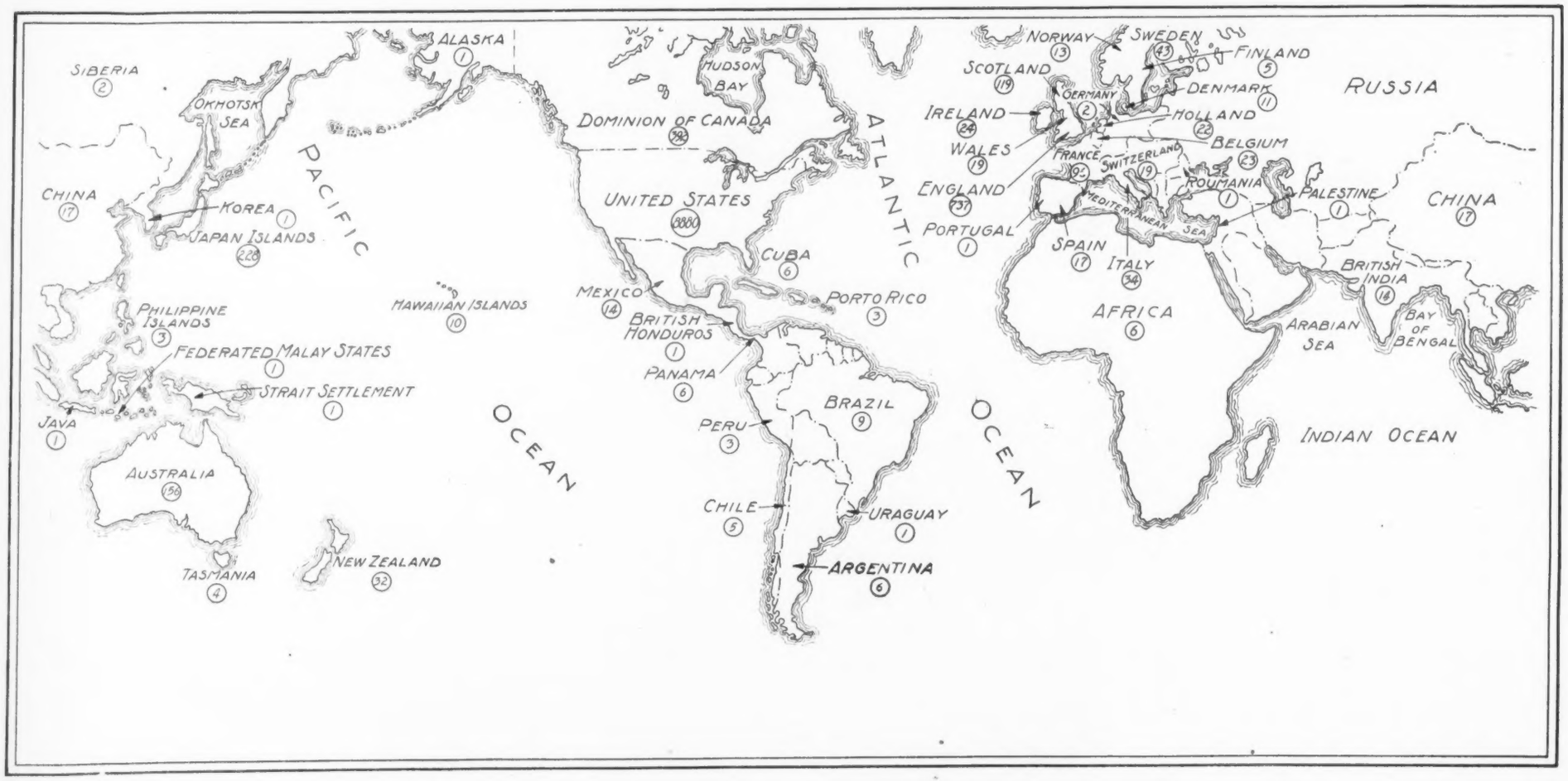
Question.—We have complaints about our malleable castings not machining easily. The castings bend well but take the edge off the tools. We also have trouble with some of our castings cracking in the hard iron. The iron runs about 0.90 per cent silicon and 3.40 per cent carbon. Please tell us what causes the trouble in machining and whether the high carbon in the iron makes it crack while in the hard state.

Answer.—The fact that iron with 0.90 per cent silicon and 3.40 per cent carbon is hard to machine would indicate either that it had not been annealed thoroughly, that it was not entirely freed from annealing scale when cleaned, or that the carbon in the skin had been oxidized out during the anneal, due to the use of a too strongly oxidizing packing. The fact that the castings bend freely would indicate that they are thoroughly annealed. There is, of course, the possibility that a few of the castings have not been entirely annealed and cause the trouble in the machining, while the ones that you have tested by bending did not include any such castings, of which there may be few. If the castings have been thoroughly annealed and you have examined them to see that all the packing scale which might have stuck to them has been removed, the only other probable cause would be the use of a too highly oxidizing packing at too high a temperature. In this case we would recommend that you mix some cast-iron turnings—possibly 20 to 30 per cent of the bulk—with the packing and see that the temperature of the furnace does not go above 880 degrees Cent.

Cracking in the hard iron would not be caused by 3.40 per cent carbon in the iron, although this amount of carbon is too high. Carbon in air-furnace iron should not run above 2.70 per cent when strength and ductility are desired. Your cracking must be due to some cause other than high carbon but it would be impossible to say what does cause the cracking unless we had further details about the shape and size of the casting and the way it is gated. If it is a cored casting and the core is too hard and does not break up readily after the casting is poured this would tend to crack the casting. The design of the casting and the way it is gated may possibly cause the trouble. One way to prevent the casting from cracking, if it is gated correctly and the core is not too hard, is to take the casting out of the sand as soon as it has set and put it into a heated furnace to cool slowly.

The firm name of the Bayonne Casting Co., Bayonne, N. J., has been changed to the Monel Metal Products Corp.

"Wherever Metals Are Cast You'll Find THE FOUNDRY"



The truth of the statement, "Wherever metals are cast you'll find The Foundry" is at once apparent from a study of the map here presented. This shows the geographical distribution of the great family of readers, bounded and limited only by the four corners of the globe. The number of subscribers in each country is as follows:

Alaska	1	Malay States	1	Japan	228	Porto Rico	3	Tasmania	4
Argentina	6	Finland	5	Java	1	Portugal	1	Uraguay	1
Australia	156	France	96	Korea	1	Roumania	1	Wales	19
Belgium	23	Germany	2	Mexico	14	Scotland	119		1718
Brazil	9	Hawaii	10	New Zealand	32	Siberia	2	Canada	392
Chile	5	Holland	22	Norway	13	South Africa	6	United States	8800
China	17	Honduras	1	Palestine	1	Spain	17		
Cuba	6	India	14	Peru	3	Straits Settlements	1	Total	10,910
Denmark	11	Ireland	24	Panama	6	Sweden	43		
England	737	Italy	34	Philippine Islands	3	Switzerland	19		

New Foreign Offices Are Established

Adequate Presentation of Foreign Developments in the Foundry Industry Demands the Building of a Complete Editorial Representation in Europe — Foreign Influence Growing Steadily

FOR MANY years, THE FOUNDRY has been ably represented by correspondents in England and France who have depicted advance in casting manufacture in those countries as well as in other countries of Europe. Although entirely adequate previous to the war, complete service to the readers of THE FOUNDRY now demands a radical forward step. Appreciation of war accomplishments abroad has awakened an interest in European foundry practice which THE FOUNDRY intends to foster and develop by affording an intimate view of the best practice wherever it exists.

Internationalizing the publication in every sense is planned and the first steps in this direction have been taken by establishing a European department of the Penton Publishing Co. with offices in Dorland House, 16 Regent street, London. H. Cole Estep, who has been editorial director of all the journals published by this company has been appointed European manager, and sailed for England Nov. 1. The editorial and business affairs of the company will be directed from this office and able writers will be selected to represent THE FOUNDRY in the various industrial centers of England, Scotland, Wales, France, Belgium and other casting producing nations of Europe. These will supplement the work of the present offices in Birmingham, England, and in Paris, France, which will be continued.

H. COLE ESTEP

JOSEPH HORTON

FRANCIS MILTOUN MANSFIELD

THE FOUNDRY has been growing steadily in prestige until at the present time it enjoys the most widespread and probably the largest foreign circulation of any technical or engineering publication in the world. Over 2100 copies of every issue are distributed in 41 countries and territories outside of the boundaries of the United States. Remoteness is no bar to the appeal of interest. In Australia 156 subscribers regularly receive THE FOUNDRY. In Japan 228 foundrymen, scientists, instructors and manufacturers are readers, while New Zealand has 32 interested and progressive subscribers. Naturally, the English speaking races are more fully represented in the subscription lists, but a comparison of the numbers of copies of THE FOUNDRY sends abroad with the total of foundries in the different countries indicates a close parallel between the number of readers and the standing of the different nations in the production of castings. England and Canada furnish an instance of this. In England alone there are 737 subscribers, while our neighboring dominion has about half as many, approximating in readers about half the relative number of castings plants in the two countries. The British Isles, including England, Wales, Scotland and Ireland have 899 readers.

The South American nations, China, Denmark, Sweden and even Siberia find much of intimate value in American foundry practice as presented in this publication. The truth of the slogan, "Wherever metals are cast you'll find THE FOUNDRY," is attested by the cosmopolitan distribution of the paper. American foundry practice depicted in the editorial pages, and the great diversity of equipment and supplies set forth in the advertisements are studiously followed abroad.

Service to the great family of subscribers both in this country and abroad demands an extension of facilities. A more complete news representation which will present the best that exists wherever it may be found is to be established.

Mr. Estep, who has been appointed manager of this new department, is well known to all readers of THE FOUNDRY through his many contributions to its columns. He has been connected with the staff of the Penton publications since 1908, and through his work he has developed a keen insight into the foundry industry by close study and contact with both the commercial and the technical phases of the business. A graduate engineer, he has had exceptional opportunities to broaden his talents by his activity in the various great technical societies of the country and through visitation and inspection of a large number of representative foundries and manufacturing plants in America and foreign countries. Joseph Horton, Birmingham, England, has been British correspondent for a number of years. Mr. Horton's contributions to this publication and his intimate contact with the industry through familiarity with the local and national foundry associations of Great Britain fit him admirably to carry on this work. Mr. Horton has charge of the Birmingham office located at Prince's Chamber, Corporation street.

Francis Miltoun Mansfield, known to readers of THE FOUNDRY as Francis Miltoun, will continue to be French editorial representative. Although an American, Mr. Mansfield has had exceptional opportunities to assemble information on French industries through

long residence in Paris. He also is thoroughly conversant with affairs in Belgium, Italy and other continental countries and is able to present the industrial thought of those countries from the American viewpoint.

Established more than 27 years ago, THE FOUNDRY has occupied a unique place in the industry. Probably no single line of endeavor has progressed more during that period than the manufacture of castings and this progress in a great measure has been effected through the interchange of ideas. In this work this publication has acted the part of a common carrier, gathering together those facts which are invaluable to foundrymen and transporting them to readers throughout the world. This work has been regarded as a trust, and the proper fulfillment of this trust at this time demands an expansion unforeseen a few years ago. Technical developments, industrial news, and manufacturing procedure abroad will be sifted for that information which will prove most valuable to the industry at large. In addition, the ever-increasing host of subscribers in European countries will be brought into closer touch with the publication and will have the benefit of more immediate personal service from a staff of trained men.

Pipe Molds Made From Rotating Patterns

TO provide a rotating pattern with effectual means for forming the enlarged upper portion of molds used in casting pipe, a Philadelphia inventor, Louis R. Lemoine, recently devised the patented pattern shown in the accompanying illustrations. Fig. 3 is a sectional elevation of the mold, Fig. 2 is a section through the pattern near the top of Fig. 3 while Fig. 1 is a section through the pattern on a lower portion of Fig. 3.

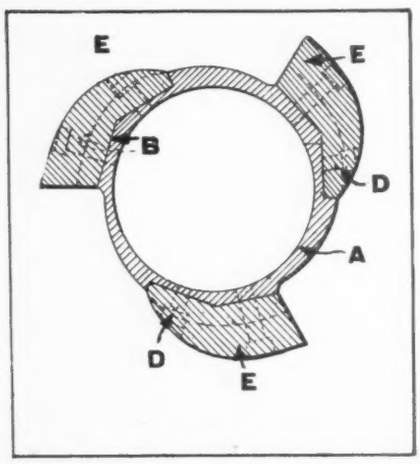


FIG. 1—SECTION THROUGH UPPER PART OF PATTERN

In the illustrations, *A* is a tubular ramming pattern having ramming ribs or cams, *B*, parallel with the axis of the pattern. These are held in place by the screws. The pattern is molded in the flask, *C*. The lower end of the pattern is centered and supported so that it can be rotated in the ramming seat member secured to the lower end of the flask by methods commonly used in making molds of this character.

The bars or cams, *B*, are each formed to fit against tapered seats formed on the outer side of the pattern body. The forward edge of each cam bar is designed with reference to the direction of rotation of the pattern and fits against a radial shoulder at the forward edge of the corresponding seat. The convex surface of each cam bar is flush with the outer surface of the body, adjacent to the shoulder, and slopes away from the center of the pattern body from the front to the rear edge of the cam bar.

The upper end of the flask, *C*, is flared outward to provide for the riser and runner basin of the pipe mold. The inventor states that his plans relate to the construction of that portion of the pattern used to form the inner wall of this part of the mold. To this end, the cam bars, *B*, are stopped at approximately the level of the upper end of the unflared cylindrical body

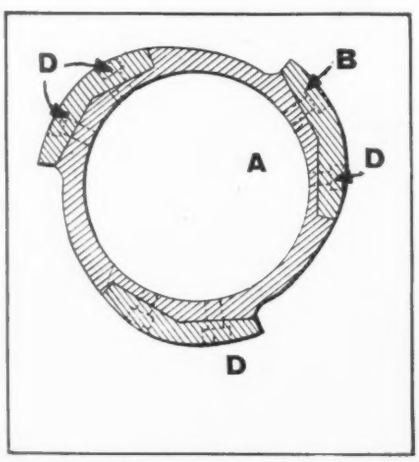


FIG. 2—SECTION THROUGH LOWER PART OF PATTERN

portion of the mold cavity but the tapered seats are continued and the shoulder is level above that of the upper end of the flask. Secured against each seat, above the corresponding cam bar, *B*, is a special set of cam bars, *E*, which are correctly contoured to form a cavity of the desired shape when the pattern is revolved.

This portion of the interior mold surface comprises superimposed conical sections, F^1, F^2 and F^3, which are of different tapers and an upper cylindrical portion, F^4. The outer rear edges of the pattern cams, *E*, are formed to coincide with the surfaces F^1, F^2, F^3 and F^4. The convex outer surface of each cam bar, *E*, is shaped to run smoothly back to the outer edge of the corresponding shoulder, where it merges into an adjacent convex surface of the pattern body.

In operation, after the pattern is mounted in the flask and the space between the pattern and the flask filled with sand, the pattern is rotated to press the sand outwardly. This operation forms the sand into a compact mass and at the same time outlines the desired mold cavity. As the pattern is rotated, sand is continually fed into the upper end of the flask until the mold is completely formed.

The cams, *E*, which form the riser and basin portion of the mold, it is pointed out, do not interfere with the downward feed of the sand between them while at the same time they serve properly to compact and shape the riser and basin portion of the mold.

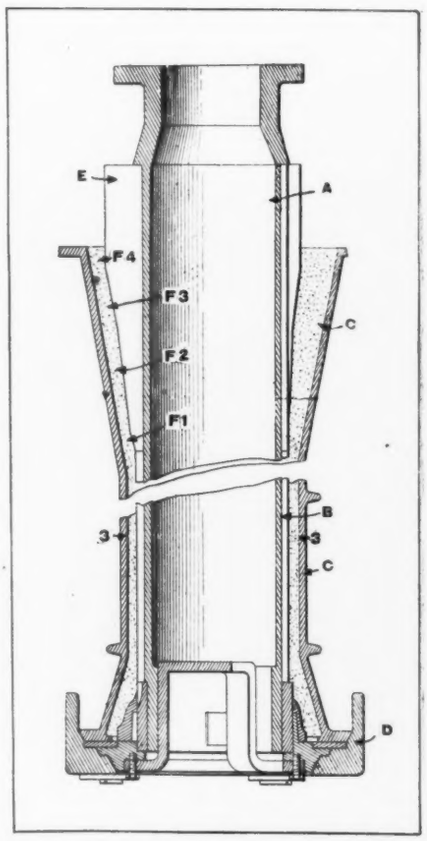


FIG. 3—SECTION OF PIPE CASTING MOLD WITH PATTERN IN PLACE

Loam Mold for Evaporator Steam Belt

THERE are three recognized commercial methods of molding iron castings, using green sand, dry sand and loam, respectively. Each has its particular advantages which may be summed up briefly as follows: The green-sand method is adapted to the production of light and medium weight castings; the dry-sand method is suitable for heavy work when the shape of the casting is of such a character that a whole pattern is necessary; and the loam method is used where the usual causes of casting losses in that lends itself readily to the building of the mold with the aid of sweeps or enough detached parts of the pattern to form an outline and act as a guide.

There are some castings made in green sand that require the highest degree of skill on the foundryman's part and the same may be said of some that are made in dry sand, but as a general rule the very fact of drying the mold affords a certain amount of insurance against some of the usual causes of casting losses in green sand.

Loam molding affords some security against the same trouble, it also makes it certain that the castings will be free from swells and strains. Loam molds will produce castings truer to weight, shape and thickness than either of the other methods, and as already pointed out, another advantage of this method lies in the fact that a great deal of expensive pattern work may be dispensed with and, further, that no flask equip-

FIG. 1—DETAILS OF FOUNDATION, LIFTING AND BUILDING PLATES

FIG. 2—THE CORE BUILT AS HIGH AS THE SHOULDER—NOTE THE OPEN BRICKWORK ALSO THE LAYER OF HAY—A CLEAR VENT WAS ESSENTIAL

ment is necessary for making the mold.

Sand molding, either green or dry, is more suited to the production of castings in quantity; for that reason the loam method is only employed in exceptional cases—where there is only one casting to make, where extreme accuracy is desired, or where the the shape is such that a considerable saving may be effected in the pattern shop.

From the very fact that castings made in loam are seldom duplicated, or at least not to any considerable extent, it follows that each one requires individual treatment and therefore a high degree of skill and knowledge are required on the part of the foundryman who produces them. Most of this knowledge comes into play before the job is actually started, in deciding the question of the most feasible way to handle the work. This point being settled, special skill also is required in preparing the necessary rigging to carry the work to completion.

An exceedingly interesting loam-molding job has recently been completed by the Kilby Mfg. Co. in its gray-iron foundry at Cleveland. The casting forms a steam belt for an evaporator and constitutes part of the installation in a sugar mill.

The casting may be described as a ring approximately 18 feet in diameter by 6 feet high with a metal thickness of 1¼ inches. It narrows top and bottom to an inside diameter of 14 feet 6 inches. There are four sets of brackets, or feet, and eight single brackets extending from top to bottom on the outside; also four sets of brackets on the inside; one to correspond to each foot or pedestal on the outside. Two openings for the exhaust steam, one on each side, 16 and 20 inches in diameter respectively, and one 5-inch opening for live steam add their quota to the sum total of interesting features in connection with the molding of this casting.

One of the most important features which had to be considered was the comparatively thin section of metal when compared with the total area and the amount of metal necessary to pour the casting. It was calculated that approximately 30,000 pounds would be required which meant that ample gating facilities and hot fluid iron would be necessary.

In preparing to make this mold, a hole 24 feet in diameter and 4 feet deep was dug in the foundry floor, a spindle seat located and a level bed struck off. A foundation or building-ring 3 inches thick was laid on this bed and centered. This building-ring was provided with 12 lugs, six on the outside circumference and six on the inside in each of which a loop made of 1-inch round iron had been cast. Two of these loops are quite distinctly shown at *A* Fig. 1. These loops were to serve as anchors in binding the completed mold together, to resist the pressure of the molten iron.

One course of bricks was built on the foundation plate and then the particular work commenced.

Since the casting was to be made in two halves it was apparent that provision must be made while molding it to produce that result. It was decided to use splitting cores 3 inches thick. This meant that the mold would have to be swept from two centers 3 inches apart. Since castings made in this manner form a regular part of this shop's output several standard spindle seats are included in the regular equipment. They are all made after the regulation cross pattern and have two, three or four holes in them accurately spaced and finished. The lower ends of the spindles are turned to half spheres and the bottom of the holes in the spindle seats are turned to conform to them. One of these seats with two holes three inches apart was used in this case.

A straight sweep was first used and the wall built up high enough for the bottom flange of the casting to rest on. A coat of loam was spread on this and the approximate position of the four feet and the flange marked on it. These pieces were then brought over from the pattern shop and located accurately. The sweep *S*, Fig. 9, was attached to the spindle and

FIG. 3—THE FINISHED CORE—PUTTING ON THE THICKNESS PIECES

the wall for one-half of the mold built up to the turn. Small grids were built in the wall at each of the four feet to carry the overhang. The spindle was then shifted to the other seat and the second part of the mold built to the same height. Building this part of the mold also included making a core seat. When the loam on this part of the mold had stiffened, a thickness of sand to correspond to the anticipated metal thickness was swept on, the sweep *T*, Fig. 10 being used for this purpose. Pieces of newspapers were used to form a parting and the core lifting plates set in position.

Each of these plates was 4 inches thick and was provided with four lugs for lifting the core and with three loops in each of which a bolt was anchored later on and carried through a gap in the top building plate where it was secured. When these bolts were tightened the core became quite rigid and was able to withstand the oscillation incident to lifting it out of the mold and transporting it to the core oven. The arrangement is shown in Fig. 6 with the openings around the loops in the lifting plate bricked in.

The foregoing is a disgression; we left the lifting plates just as they had been set in position. A thickness of loam was laid up against the "pattern" and the brickwork carried up to the shoulder. When this point was reached mud was spread on the brickwork and loam on the "pattern" and a row of special cast-iron gaggers 2 x ½ inch bedded in horizontally all around to carry the overhang. The building then proceeded until the core was one brick higher than the unfinished outside wall. As the last course was being laid, the inside brackets *C* and *D*, Fig. 1, were located and built firmly into place. A vertical parting was made at the center line and covered with newspapers.

FIG. 5—THE TWO DRAWBACKS—NOTE THE OPENING LEFT FOR HEAD METAL—THE FLANGE WAS EXTENDED TO THE TOP OF THE MOLD

At this stage the spindle was shifted and the other half of the core built to the same height. The third and fourth sets of interior brackets were set during the building of this part of the wall.

Building plates as shown at *P*, Fig. 1, were then bedded on both halves of the core wall. These plates were perforated to allow the steam to escape and were each provided with three loops to facilitate handling them. The sweep in Fig. 1, was next attached to the spindle and one-half the core built up to the shoulder. At this point another building ring was set on. It may be seen at *K*, Fig. 2. After bedding this ring down firmly a rough coat of loam was swept on the face of the core. The brickwork forming the shoulder was then proceeded with. It was laid more openly than usual and in addition, a layer of hay was scattered between the two courses of brick. These precautions were taken to prevent any boiling or bubbling of the metal while flowing over the shoulder.

All the flanges are marked "finish"; furthermore the castings had to be steam tight and therefore any boiling or ebullition of the metal would have been fatal to success.

The half core was built to the top, loamed and finished, and a vertical parting made at the center line. Newspapers were pasted on this parting as on the other parting farther down. In fact newspapers were the only parting agents employed anywhere on the mold. The spindle was shifted again and the other half of the core built after the manner of the first. The completed core is shown in Fig. 3.

In order to secure the proper thickness between the inside and outside walls of the mold, a row of slightly tapered 1¼-inch staves was stood up against the core all around. These are shown partly assembled in Fig. 3. All the brackets on the outside were then set by the aid of a long straight-edge and plumb-bob.

For the sake of clearness it should be mentioned here that the brackets were each made in three pieces. The lower sections were built into place when the lower part of the outside wall was going up; the second, or middle section was placed in its proper position on the part of the mold now under discussion and the

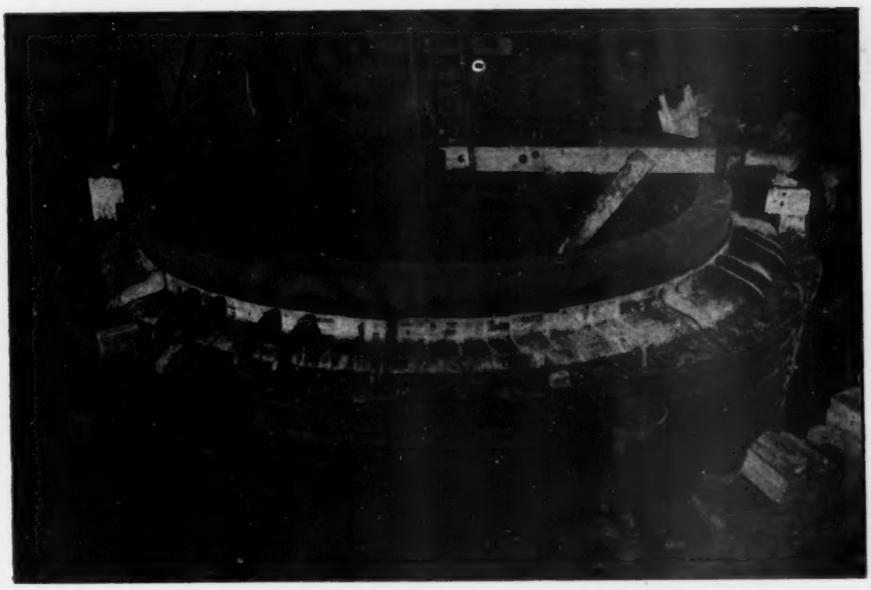


FIG. 4—THE BRACKETS ALL SET—THE LAST OF THE LIFTING PLATES IN POSITION

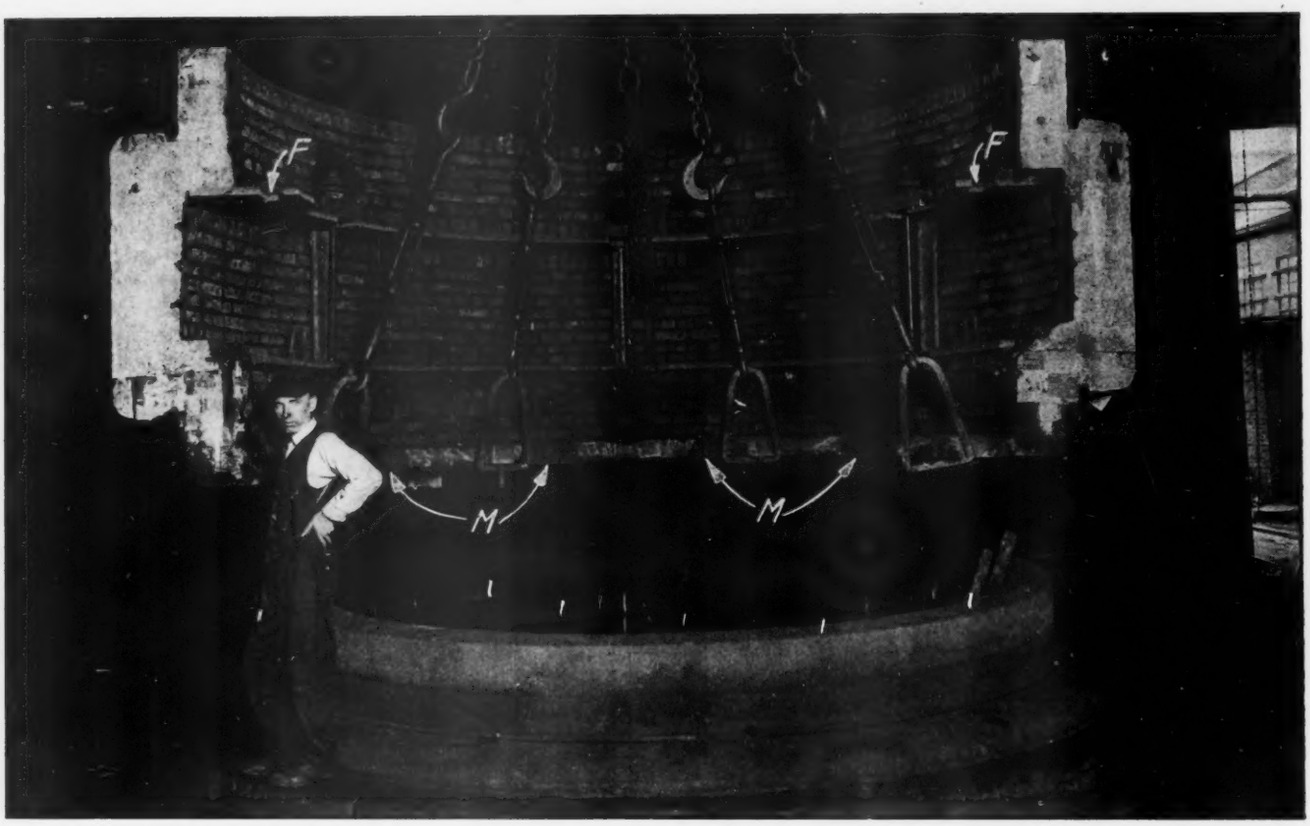


FIG. 6—LIFTING OUT ONE-HALF OF THE CORE—THREE BOLTS HELD THE CORE RIGIDLY TOGETHER

third or top sections were set on after the outside wall was built as high as the shoulder.

Besides the brackets and staves, two horizontal gates were set opposite the point where the parting came in the mold at each side. These gates were carried through the outside wall where each pair connected with a down gate 4 inches square. On the inside the gate was divided, a branch 4 x 1 inch going to each side of the splitting core.

When all the loose pieces had been set, the outside wall was built right

FIG. 7—THE FINISHED MOLD READY FOR THE IRON—THE BINDERS WERE HELD DOWN BY 12 BOLTS ANCHORED TO THE FOUNDATION PLATE

up against the staves surrounding the core. The loose pieces for making the steam openings were set up and built into place after the wall had reached a sufficient height. Building was then continued until within 2 inches of the upper turn. At this point the sweep *M*, Fig. 9, was put on, a thickness of sand swept on the shoulder all around to correspond to the thickness of metal and a parting made. This parting was covered with newspapers and the lifting plates, one of which is shown in Fig. 4, were set on. In this illustration the half core in the rear is finished while the plate in the foreground has just been set in position. The upper sections of the brackets are all in place. It will be noted that there are seven loops in the plate. They will be referred to again.

A thickness of loam was spread over the plate and pattern; long stiff rods were bedded in at close intervals and the remainder of the wall built up until it was flush with the top of the core. Instead of covering the top flange and taking off a few risers it was decided to extend the flange upward 6 inches to the top of the mold and pour the casting open, the extra thickness to be cut off in the machine shop afterward. This extension or continuous riser was made by attaching a rectangular piece to the sweep and thus forming a trough.

After the outside wall had been built to the top a covering plate 2 inches thick was bedded on each half. Seven 2 x 4-inch holes were provided in each of the plates through which ¾-inch bolts were dropped and hooked into the loops previously referred to in the lower plates. Then the nuts and washers were put on and the bolts drawn up tight.

These plates also had three rectangular holes near each end to accommodate three pop gates 2½ x ½ inch meant to supplement the main down gates and insure the casting against cold shuts.

When everything was ready the crane was hooked on to four lugs provided on each of the top plates for that purpose. They were taken off and set on blocks to be finished and are both shown in Fig. 5, one resting on the other. Parts of the outside down gates are shown at *O* in the same illustration.

The false thickness of sand was then taken off the shoulder of the core and afterward the upright staves were pulled out, one at a time. These staves were slightly tapered on the flat side to offset the extra thickness bound to develop, owing to the strain on the lower part of the mold.

On account of the peculiar shape of the half core it was a ticklish job to get it balanced but after a few adjustments of the turnbuckles this was accomplished. The first half to be lifted is shown in Fig. 6. An idea of the actual size of the core may be gained by comparing it with the relative size of F. J. Grondie, foundry superintendent, who is shown standing alongside. Each half, as it was lifted, was taken directly to one of the core-oven cars, lowered off and finished. In this connection it is interesting to note that while one of the cars carrying a core was going into the oven, one of the front wheels broke. It was necessary to jack up one corner of the car, take off the broken wheel and put on a spare one, which fortunately was on hand. While the cores were drying, the outside wall of the mold was finished and the different loose pieces drawn in. The mold was then finished, blacked, slicked and dried. Drying was accomplished by placing a number of salamanders in the mold and building coke fires in them.

In assembling the mold for casting, the splitting cores were set in first. Each of these cores was in three pieces, one straight section for the upright wall, one for the lower shoulder and one for the upper. They were provided with six ¾-inch grooves *L*, Fig. 9, on the edges which came in contact with the main

FIG. 8—TWO LADLES WERE USED TO POUR THE CASTING—THE IRON ENTERED THE MOLD THROUGH FOUR BOTTOM GATES EACH 4 X 1 INCH AND 12 POP GATES EACH 2½ X ½ INCH

core. These grooves formed passages and were for the purpose of equalizing the height of the rising metal in case one set of gates should take it faster than the other.

The cores for the steam passages in the sides were set in next; but were kept back about ½ inch to afford clearance in lowering the main cores.

The main cores were taken off the cars one at a time, particular attention being given to seeing that they hung perfectly level and plumb. They were lowered into place in turn and shown in Fig. 7, the mold at this stage being complete and ready for the iron. The method adopted for binding the mold together is also shown in the same illustration.

In order to prevent the iron breaking through at the vertical parting in the core, the wall was made flush at this point, mud daubed on and a piece of plank rubbed into place on each side. The planks were secured by wedges driven in the gaps provided in the top and bottom plates and shown at *F F*, Fig. 6, and at *G*, Fig. 1. In order to facilitate handling inch cupola at a coke and iron ratio of 1 to 10.

F. J. Grondie, foundry superintendent, and Chas. F. Smith, superintendent of the pattern shop, collaborated in the planning the work and as a result there was not a hitch at any stage of the game. The building of the mold advanced steadily day by day until it was finished.

Building rings and lifting rings were available when needed. Lifting hooks, gaps, vent holes and gate holes were always found to be in their appointed places as the molding progressed,

FIG. 9—THE PATTERNS, COREBOXES AND SWEEPS FOR THE STEAM BELT

located by marks *M*, Fig. 6, which had been put on before the cores were lifted in the first place. When these cores had been set the cores for the steam inlet and exhaust were pushed up hard against them, after which the openings in the wall were daubed up.

The two half covering parts of the mold were then set on and brought into place by a set of loam marks similar to those used on the core. Flat slab cores were laid up against the gates shown at *O*, Fig. 5; sand was shovelled in and the pit rammed firmly. From the floor level to the top of the mold the sand was held in position by a sectional sheet iron curbing fastened together by an ingenious arrangement of bolts and cotter pins. The general features are the casting with the shop traveling cranes, three loops were suspended in the open part of each half of the mold. Two of these loops are shown at *H*, Fig. 7.

Before commencing to pour the iron, the plugs *R*, Fig. 7, were set in the runner boxes, one over each gate opening. They were left in until the basins were full and then lifted out. The basins were thereafter kept filled until the pouring operation was completed. In Fig. 8, the ladles are shown nearly empty and the glow from the rising iron may be seen in the open ring forming the top of the mold.

A 9-ton ladle holding eight tons of iron and a 15-ton ladle holding nine tons were used in pouring the castings. The iron was melted in a 72- and the patternmakers supplied the loose pieces, helped to locate them in their proper places in the mold and changed the sweeps each time it was necessary. A complete pattern was not used but an idea of the number of loose pieces may be gained from Fig. 9 which shows every piece used in connection with this particular job.

The American Crane Co., Inc., has recently been organized and has taken over the manufacturing interests of the Barber-Foster Engineering Co., at Friendship, N. Y. The plant has been extensively enlarged and improved with additional new equipment. The Barber-Foster Engineering Co., 602-603 Swetland building, Cleveland, O., will act as exclusive distributors.

Equipment and Methods of Tinning

Details of Pickling to Prepare Gray-Iron and Malleable Castings for Receiving Coating of Tin — Processes Varied for Different Classes of Work — Troubles With Gray Iron

BY E. P. LATER

Little has been written in foundry literature on the work of tinning and pickling, so this article by E. P. Later is especially interesting. The writer's description of pickling processes with details for handling the various classes of work will benefit many foundrymen who have experienced trouble pickling their castings. The methods given for pickling gray-iron and malleable castings are outlined in careful detail and may be followed easily in pickling not only for tinning but for any other purpose.

IN AN article published in the May 15 issue of THE FOUNDRY the process of hot-dip galvanizing was considered at some length. This process gives a zinc coating which is exceedingly rugged and efficient, from the protective standpoint. It is not, however, entirely satisfactory for all purposes and on various iron parts such as saddlery hardware, containers, cooking utensils, etc., a tin coating is generally used. In its superficial aspects hot tinning resembles hot galvanizing in that the parts to be treated are first thoroughly cleaned and then immersed in a bath of the molten metal; nevertheless, there are certain differences in manipulation and treatment which will be considered in this article.

As in the case of galvanizing, a quantity of acid fumes and steam is given off in the operation of a tinning plant. It is, therefore, advisable to isolate it as far as may be practicable from the remainder of the factory, while ample provision should be made for producing thorough ventilation and removal of fumes, preferably by an exhaust system. Steam will be required for heating some of the tanks and there should also be available plenty of water and good sewer connections.

A List of Equipment

In the matter of the equipment needed, a good deal depends not only on the amount of work to be done, but also on the class of work as well. For instance, when it is desired to give wrought iron, steel or malleable parts a tin coating which shall be of ordinary smoothness and appearance, the preliminary treatment will usually involve pickling to remove rust and scale, or tumbling with shot, followed by a single dip in the tin. Practically, there would be needed, then, only the necessary tanks for the acid pickles, an iron tank for a strong alkali solution, one or two cold-water tanks for storing pickled work before it is tinned, a tank or jar for the zinc chloride flux into which the work must be dipped before tinning, one tinning kettle, a tank of kerosene oil for cooling the tinned parts and a tank of clean, hot water for rinsing them off.

On the other hand parts which must have a very smooth and bright coating will require more careful preliminary treatment. It will be necessary to give such parts a more or less prolonged tumbling or rolling with gravel and water or with leather scraps. Two or three kettles instead of one will be employed for tinning them. The first kettle, known as the roughing kettle, serves merely to coat the articles, while immersion in the other kettles removes any irregularities and excess of metal and produces a smooth, uniform coating.

When designing a tinning plant one must, therefore, be guided in the selection of equipment very largely by the class of work to be turned out. The general design of tanks and tumbling barrels has been treated in previous articles and inasmuch as such equipment is more or less familiar to every one, further description is not necessary. Tinning kettles may be constructed of either cast or wrought iron and are mounted in furnaces of simple design, after the fashion of a galvanizing kettle. Coal, coke, gas, oil or even wood may be used as fuel, although in some ways hard coal is perhaps the most satisfactory.

The implements used in tinning are very simple. Large pieces of work to be tinned are held with tongs while they are being immersed, and small parts are placed in baskets made of perforated sheet iron or wire mesh, or they may be strung on wires.

Proper control of the temperature is a matter of considerable importance in the production of good tinned work. At high temperatures the oxidation of the tin takes place rapidly and more or less of the oxide is certain to adhere to the tinned parts, resulting in a rough and inferior-looking coating. On the other hand, carelessness in manipulation or the use of too low a temperature will cause the coating on the parts to be thick and lumpy with consequent loss of tin.

In galvanizing and, in fact, in most manufacturing processes, labor cost is greater than the cost of the materials used. A small waste of the latter may, therefore, be more than overbalanced by a resultant saving in time. With tinning, however, the reverse is generally true. Tin is a rather expensive metal, particularly so during the past two or three years, and waste of tin is certain to be reflected in the cost of doing the work. Tinned articles are as a rule held to a fairly high standard of appearance, but aside from this it is a paying proposition to maintain consistently a sufficiently close control of the various factors influencing the tinning process to insure the production of a clean, smooth coating.

Pyrometer an Aid

Tin melts at a considerably lower temperature than zinc, consequently a tinning kettle is maintained at a lower degree of heat than a galvanizing kettle. A temperature of 700 degrees Fahr. is about right when only one kettle is used. When a higher grade finish is desired, necessitating the use of two or more kettles, the first should be maintained at approximately 700 degrees Fahr., while the second, which is covered with upwards of an inch of molten tallow, should be kept around 600 degrees Fahr., although certain classes of small work may require a higher temperature, say 650 degrees Fahr. As a general rule the tin in the second or finishing kettle should be kept at as low a temperature as is consistent with good work.

In the matter of temperature control a good pyrometer or thermometer will be of the greatest as-

sistance and is well worth having. Care should be taken to see that these instruments are accurately calibrated in the first place and inasmuch as both undergo a certain amount of change or deterioration after long use it is advisable to check them up now and then.

Upon the thoroughness and skill with which the parts are prepared for tinning depends in large measure the character of the resultant finish. The purpose of the preparatory operations is, of course, to put the surface of the articles in condition to take a tin coating which will be of what is deemed satisfactory appearance in every respect. But inasmuch as there is some divergence in the requirments which the finish on different articles must meet there is necessarily a corresponding difference in the preparatory processes. For example the finish on one class of parts may be considered satisfactory so long as the tin covers the entire surface and is reasonably smooth and uniform; little attention may be paid to irregularities of the surface, although these may be a most important factor in determining the appearance of the coating. The requirements for another class of work may be such that it is necessary to finish the surface very highly before tinning, so that the coating may be as smooth as possible. Adding to this the fact that parts vary considerably in the amount of work needed to give the surface the desired degree of smoothness, it can be appreciated that there is a rather wide variation in the methods employed.

Various Methods Employed

It generally comes down to the fact that each class must be considered by itself. When the quality of finish desired has once been decided upon it is simply a matter of working out the processes which best will give the requisite surface. For this reason it is rather difficult to formulate any procedure which will be applicable in every case; about all that can be done is to outline in a general way the methods which are ordinarily employed, on the basis that certain processes are to be omitted or the details varied as conditions indicate.

Wrought iron and malleable parts require a different treatment from gray-iron castings and the methods to be employed in their case will be considered now. Rust and scale can be removed in several ways: The first, sandblasting, is so well known that little need be said about it. Another method is the familiar pickling process which involves the use of some acid. A hot solution of sulphuric acid, one gallon of acid to 6-10 gallons of water, is usually employed; hydrochloric acid, otherwise known as muriatic acid, can be used if desired, but it is more expensive and does not offer any particular advantage.

One of the drawbacks to the use of acid is the danger of overpickling. Scale, particularly, adheres in some spots more strongly than in others and if the parts are kept in the pickle long enough to remove all of the scale there is a very good chance that a portion of the surface will be badly attacked by the acid, thus becoming rough and seamed. Such a condition will, of course, be reflected in the inferior appearance of the coating. Knocking or chipping the scale off in the places where it is unusually heavy or strongly adherent is highly advisable. By doing this time and acid will be saved and in addition the danger of overpickling will be lessened.

Mechanical agitation of the parts while they are in the acid will also do much to insure good pickling by preventing the parts from staying too long in contact with each other and thus shielding certain areas from the action of the acid.

Owing to the fact that sand is not attacked chemically by sulphuric or hydrochloric acids its removal by these agents is rather a slow and unsatisfactory process. Hydrofluoric acid on the other hand dissolves the sand without attacking the iron to any extent and works well when diluted with from 20 to 40 parts of water.

Sandblasting or pickling does not, of course, produce a smooth surface in the sense of removing surface irregularities. Used without further preparation of the article to be tinned, these processes are ordinarily suitable for only the cheaper grades of work, where a very smooth coating of tin is not demanded. Because of this and also on account of the fact that pickling is a disagreeable and not altogether satisfactory process at best, tumbling in a suitable container or barrel is frequently resorted to.

Tumbling the parts with small iron pieces of irregular shape, known collectively as shot, affords a convenient means of removing sand, rust and scale and producing a more or less smooth surface through the removal of at least some of the most pronounced irregularities. When the tumbling is well done, in the way of loading the barrels properly and allowing them to tumble for a sufficient length of time, it is possible to produce a surface which is quite smooth and so free from rust or scale that little or no pickling will be required.

Tumbling with sandstone chips, sand or other fairly fine abrasive is frequently employed to cut down and smooth off the surface of castings and other parts. The usual procedure is to fill the tumbling barrel with both large and small pieces, after which a wheelbarrow load or so of the abrasive, the exact amount will depend on the size of the barrel and other factors and must be determined by experiment, is dumped in and the barrel then filled with water. It is customary to add a few ounces of cleaning compound or other alkali for each gallon of water.

Brightening the Work

When the surface of the work has been sufficiently cut down the sand and dirt in the barrel should be washed out with water. After this treatment the parts will be smooth, but not very bright. To brighten them will require further tumbling or rolling, either wet or dry. A very good finish can be obtained by tumbling the parts in water containing a few ounces per gallon of alkali, and perhaps an ounce or less of sodium cyanide. Rolling the parts with coarse gravel and water is also employed as a cheap and convenient means of producing a very smooth and bright finish.

If dry tumbling is preferred the work is subjected to the polishing action of leather scraps, either with or without the addition of a small amount of fine alundum.

Ball burnishing, tumbling with small, polished steel balls, the size of which depends on the character of the work, has been coming into favor the past few years and when properly carried out is capable of producing a finish which is practically as good as is obtained by buffing. This process can also be conducted in the wet or dry way. In the first instance after the proper amount of parts and steel balls have been put into the barrel it is filled with water to which has been added some alkali, soap chips or other substance of this nature and the whole revolved until a satisfactory finish is obtained. In order to effect a quick separation of the balls from the parts under treatment the barrel is usually emptied onto a screen of sufficiently coarse mesh to allow the balls to pass through, while the parts are retained.

For immersion in the tin the ar-

ticles, depending on their size and shape, are held by suitable tongs, placed in perforated iron or wire baskets or strung on iron wires. Before they are put into the tin a final cleaning and fluxing is necessary. The first step is usually a few minutes immersion in a hot and fairly strong alkali solution for the purpose of removing any grease which may have been deposited on the parts through handling. Upon removal from the alkali they should be well rinsed in clean water and then given a dip in hydrochloric acid diluted with 10 times its volume of water. In cold weather a somewhat stronger solution is desirable. The purpose of this dip in acid is to remove any traces of rust which may have developed after the preparatory operations described above, and prolonged immersion is ordinarily not required.

Flux is Required

The last step before tinning is to dip the parts into a flux of zinc chloride, which is necessary to insure the parts taking the tin promptly and uniformly. This flux is made by dissolving as much zinc scraps in strong hydrochloric acid as will go into solution. The parts are dipped into this solution and then put directly into the molten tin, where they must remain until they reach the temperature of the metal, when they may be taken out.

A clear space should then be skimmed on the surface of the bath, so that the flux will not adhere to the parts as they are drawn out. It may be mentioned here that the dross which floats on the surface of the tin is frequently the cause of inferior work, particularly when only one kettle is used. Unless care is exercised it will adhere to the parts when they are taken out of the tin. The surface of the metal should, therefore, be skimmed frequently with a perforated skimmer, the holes in the skimmer being large enough to allow the good tin to flow back freely. In the same way the amount of the black flux which forms on the surface of the tin from the zinc chloride into which the parts are dipped before tinning should be kept down by skimming some of it off now and then. If it is allowed to cling to the tinned parts the appearance of the finish will be impaired.

If two kettles of tin are employed the parts are plunged at once into the second or finishing kettle which is covered with about one-half inch of molten tallow and kept at a temperature somewhat lower than that of the other kettle, the exact temperature depending on the size of the work. A very short immersion will usually suffice and then the parts should be taken out, shaken or swung to remove the surplus tin and dipped into kerosene oil for a moment to set the tin coating. After this they should be placed in boiling water and then dried in sawdust.

If only one tin kettle is used the work, after withdrawal from the tin, is swung to remove the excess metal and then cooled and dried as before.

The ordinary run of gray iron does not take the tin so readily as wrought or malleable iron and a great deal of trouble is often experienced in obtaining a good coating. Further, it is sometimes very difficult to determine just what is the matter. Often one lot of castings will finish up without any particular difficulty, while it will be practically impossible to tin a second lot which is apparently the same as the other. Presumably the explanation is to be found in the composition of the castings. Gray iron contains considerably larger amounts of silicon, carbon, etc., than wrought or even malleable iron and when these impurities go beyond a certain point it appears that trouble is generally encountered in tinning the castings satisfactorily. For this reason it is advisable to keep a close check on the quality of the castings. In particular, the use of miscellaneous cast-iron scrap, such as is obtained from junk dealers, is a likely source of trouble and if such material is used at all sufficient care should be exercised to insure the production of castings of uniform and proper composition.

Tinning Gray Iron

To insure proper tinning gray-iron castings as a rule not only require special treatment, but very close attention must be paid to all of the details of the various processes. It can hardly be emphasized too strongly that unless the surface is thoroughly clean and in the proper condition it will be very difficult or impossible to obtain a satisfactory coating. The man who cuts the corners too closely in his efforts to tin gray iron a little more cheaply than some one else, usually finds himself wondering why he has so much trouble in turning out good work while his competitor down the street gets the cream of the business. The chances are that this competitor does not take any unnecessary risks in trying to save a few pennies and in consequence turns out work that enables him to demand and get a good price.

The first step in preparing gray-iron castings for tinning is, of course, removal of sand and scale and for this purpose it is advisable to use either the sandblast or the ordinary tumbling barrel, wherein the parts are tumbled with iron shot until all foreign matter is knocked or rubbed off.

A pickling bath of either sulphuric or hydrofluoric acid can be employed if desired, but the use of the former is hardly to be recommended for cleaning gray iron. In the first place it does not attack the sand itself, but removes it simply by dissolving the iron from underneath it and unless a great amount of care is exercised the surface of the iron is left covered with a soft, gummy substance which must be removed before the subsequent operations can be carried out. If tumbling barrels are not available or the castings are of such character that they can not stand tumbling, a bath made of one part of hydrofluoric acid to 30 or 40 parts of water should be used as a pickle for removing the sand.

Obtaining a Smooth Coat

The best results are obtained, particularly when a bright, smooth coating of tin is desired, by tumbling the castings under gas pressure after the sand has been removed by any of the methods just described. As a matter of fact, it is very difficult or impossible to tin some castings without subjecting them to this treatment.

After the preliminary cleaning operations if the castings have become gummy through overpickling, have been made with rosin cores or are greasy, it will be necessary to immerse them for a few minutes in a boiling, strong solution of caustic soda or other alkali. After thoroughly rinsing in water they will be ready for tumbling in the acid and salammoniac.

The barrels used for this are strongly built of iron, to withstand the pressure of the gas generated during operation, and are provided with one or more safety valves which serve to release some of the gas when the pressure goes beyond a certain limit, ordinarily around 40 pounds per square inch.

The castings are placed in the barrel with a quantity of shot, the amount of this required will vary with the character of the work under treatment, and the barrel is then filled about three-quarters full of water. About 15 pounds of commercial hydrochloric acid and 2 pounds

of granulated salammoniac should then be added, the cover put on and the barrel started. This gives a combined scouring and chemical action.

The action of the acid on the iron results in the liberation of large amounts of hydrogen gas and after the barrel has been rotated for a few minutes the pressure will become great enough to open the valves. Hydrogen is very inflammable and forms an explosive mixture with air when the latter is present in certain proportions, hence naked flames should be kept away from a barrel which is in operation to guard against possible ignition.

Castings ordinarily require to be tumbled three or four hours, although some may require more and others less than this. Insufficient tumbling means an improperly prepared surface which will not finish up satisfactorily, while overly prolonged tumbling or the use of too much acid will soften the surface and make it difficult or impossible to obtain a good coating of tin. When it is considered that the parts are in the proper condition the barrel should be emptied and the castings thrown immediately into water where they should remain until needed.

The surface of the tin in the roughing kettle must be covered with a flux made by boiling zinc chloride, hydrochloric acid saturated with zinc, on the molten tin and adding white salammonia at once. This flux is, when properly prepared, a thin liquid and should be kept in this condition by adding more zinc chloride and salammoniac as needed and skimming out any hard lumps present.

Treatment After Tinning

The castings which have been cleaned and made ready for tinning should now be placed in wire baskets or strung on iron wires and immersed, first in a boiling solution of caustic soda for a minute or so and then rinsed thoroughly in running water. After this they should be dipped in a weak pickle of hydrochloric acid, one gallon of acid to 30 or 40 gallons of water, and finally immersed in a bath of zinc chloride, made by saturating hydrochloric acid with zinc and adding 5 pounds of salammoniac per gallon of solution. From this they are passed directly into the molten tin where they should remain until they have received a perfect coating of metal. Anywhere from 5 minutes to ½ hour or more may be needed for this. After this a clear space should be skimmed on the surface of the tin and the parts quickly removed and transferred to the finishing kettle which, if only two kettles are used, should be covered with nearly an inch of molten tallow. In doing this care must be exercised not to allow any dross or flux to adhere to the parts and thus get into the finishing kettle. The work should be allowed to remain in this kettle only a few seconds and then be removed and, after a few quick swings to get rid of surplus tin, immersed in kerosene oil until the tin sets. When cool it should be put into boiling water for a short time and then dried in sawdust.

When three kettles are used, for the purpose of getting a still finer and smoother finish, the second one should, like the first, be covered with a zinc chloride and salammoniac flux, while the finishing kettle should be covered with tallow.

How Treatment Affects Bearing Metal

A PAPER giving results of tests made on bearing metal was presented by Hilda E. Fry and W. Rosenhain at the meeting of the British Institute of Metals, Sept. 24-25, Sheffield, Eng. In order to study the effects of variations in pouring temperature, the use of chills, and peaning, samples were made of an alloy composed of copper, 4.4 per cent; antimony, 8.76 per cent, and tin, 86.84 per cent. Test castings were then poured in sand molds at 300 degrees, 400 degrees and 600 degrees Cent., and examined under the microscope. In each case there was a marked diminution in the number of relatively large crystals at the bottom of the ingot, and a corresponding increase at the top.

At the lowest temperature at which samples were poured the metal contained large crystals of one of its constituents before pouring and the structure was therefore not uniform. The casting poured at 600 degrees Cent. had a very coarse crystallization, with cuboids reaching 0.09 millimeters in diameter. Where the temperature of casting was 400 degrees Cent. the cuboids still were large, being about 0.07 millimeters in diameter, but the copper-tin constitutent did not form the network characteristic of very slow cooling.

In the chill castings there was considerably less difference between the ingots poured at different temperatures. The tendency of the cuboid crystals to become concentrated toward the top of the ingots, as seen in the more slowly cooled sand castings, is absent in the chill castings. It was found that the variations of the brinell numbers were relatively small, the lowest value being 25.2 and the highest 32.7. On the whole, however, the hardness numbers were higher in the chill cast ingots than in those cast in sand molds.

Six ingots were hammered and tested for hardness, the tests being made on the hammered face within 10 minutes of that operation, and after only a very little of the surface had been removed by grinding. The ingots were kept for half an hour at 100 degrees Cent. and retested. The results showed that while peaning alone, so far from hardening this alloy, actually brought the hardness number down to a small extent, hammering followed by annealing at 100 degrees Cent. resulted in appreciable softening. Microscopic examination of the specimens which had been subjected to peaning showed that both the cuboid and the copper-ton crystals had been, to a certain extent, crushed and broken by this treatment.

The authors in summing up, state, "the practical question whether a bearing is injured or improved by hammering is left open, although it is difficult to believe that treatment which shatters the harder crystals can be advantageous."

Offers Training Course in Torch Welding

The Davis-Bournonville institute, which was devoted exclusively during the war to the training of soldiers and sailors in the use of the oxy-acetylene torch, was released from government control in the spring of 1919 and now is open to men who can qualify for the training required. This course is maintained by the Davis-Bournonville Co., Jersey City, N. J. The instruction offered requires three weeks attendance during which period the student is trained in welding steel, cast iron, aluminum and bronze, and is given lectures on gases, combustion, flame, heat, welding, work preparation, expansion and contraction, and many other subjects intimately connected with welding.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

This sheet may cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

DATA ON BELTS AND PULLEYS

By W. L. Tryon

Horsepower Transmitted by Belts

The horsepower transmitted by a belt depends upon the velocity of the belt (see data sheets 301 to 306), the angle of contact of the belt on the smaller pulley and the area of belt cross section.

The angle of contact is found on preceding data sheets, as follows: On the line headed by the difference between the given pulley diameters find the distance between centers which is the nearest one below the given distance between centers. Then the angle at the top of the column will be the required angle. For example, suppose the given pulley diameters are 9 inches and 27 inches and the distance between centers is 60 inches. Then the difference between diameters is 18 inches. In the table on the line opposite 18 inches it is noted that 60 inches lies between the two given distances 51.8 and 68.9. The smaller distance is 51.8 and as the column, in which it lies is that for 160 degrees, the angle of contact is 160 degrees. This does not give the exact angle, but is a close approximation.

The horsepower per square inch of belt area is found by using data sheets following, using angle of contact found as above and velocity of belt in table next below that of the given belt. For instance, if the given pulley is 27 inches in diameter running at 250 revolutions per minute we find from data sheet 303 that the velocity of belt is 1767. The next under this in the horsepower table is 1750 and with an angle of contact of 160 degrees, the horsepower per square inch of belt cross section would be 7.74.

The horsepower transmitted by a given belt is found by multiplying the cross section area by the horsepower per square inch.

The area required for a given horsepower is found by dividing the given horsepower by the horsepower per square inch.

(Continued on Data Sheet No. 310)

DATA ON BELTS AND PULLEYS

By W. L. Tryon

(Continued from Data Sheet No. 309)

Horsepower Per Square Inch of Belt Section, Based on Barth's Formula

Velocity of belt ft. per min.	Horsepower per sq. in. of belt section when angle of contact of belt with smaller pulley is												
	180°	175°	170°	165°	160°	155°	150°	145°	140°	135°	130°	125°	120°
250	1.05	1.03	1.00	.98	.96	.94	.92	.90	.87	.84	.82	.80	.77
300	1.29	1.27	1.24	1.21	1.18	1.16	1.13	1.11	1.07	1.04	1.01	.98	.95
350	1.53	1.51	1.48	1.44	1.40	1.38	1.34	1.32	1.27	1.24	1.20	1.17	1.13
400	1.77	1.75	1.71	1.67	1.63	1.60	1.56	1.53	1.48	1.44	1.39	1.36	1.31
450	2.02	1.99	1.94	1.90	1.86	1.82	1.78	1.74	1.69	1.64	1.59	1.55	1.49
500	2.27	2.23	2.18	2.14	2.09	2.04	2.00	1.95	1.90	1.85	1.79	1.74	1.68
550	2.52	2.47	2.42	2.38	2.32	2.29	2.22	2.17	2.11	2.06	2.00	1.94	1.88
600	2.77	2.72	2.66	2.62	2.55	2.54	2.44	2.39	2.32	2.27	2.21	2.14	2.08
650	3.02	2.97	2.90	2.86	2.79	2.78	2.66	2.51	2.54	2.48	2.42	2.34	2.27
700	3.28	3.22	3.15	3.10	3.03	3.00	2.89	2.73	2.76	2.69	2.62	2.54	2.46
750	3.53	3.47	3.40	3.34	3.27	3.20	3.12	3.05	2.98	2.90	2.82	2.75	2.65
800	3.78	3.71	3.65	3.57	3.50	3.42	3.34	3.26	3.19	3.10	3.02	2.93	2.85
850	4.03	3.95	3.89	3.80	3.73	3.65	3.56	3.48	3.40	3.31	3.22	3.13	3.04
900	4.28	4.20	4.13	4.04	3.96	3.88	3.78	3.70	3.61	3.52	3.42	3.32	3.23
950	4.53	4.50	4.37	4.28	4.19	4.11	4.01	3.92	3.82	3.73	3.62	3.52	3.42
1000	4.78	4.70	4.61	4.52	4.43	4.34	4.24	4.14	4.04	3.94	3.83	3.72	3.61
1050	5.03	4.95	4.85	4.76	4.67	4.56	4.46	4.36	4.25	4.14	4.03	3.91	3.80
1100	5.28	5.19	5.09	5.00	4.90	4.79	4.68	4.58	4.46	4.35	4.23	4.11	3.99
1150	5.52	5.43	5.33	5.24	5.13	5.02	4.90	4.80	4.68	4.56	4.43	4.31	4.18
1200	5.77	5.67	5.57	5.47	5.36	5.25	5.13	5.02	4.90	4.77	4.64	4.51	4.37
1250	6.01	5.91	5.80	5.69	5.58	5.46	5.34	5.23	5.11	4.97	4.84	4.70	4.56
1300	6.25	6.15	6.03	5.91	5.80	5.68	5.55	5.44	5.31	5.17	5.04	4.89	4.75
1350	6.49	6.38	6.26	6.14	6.02	5.90	5.77	5.65	5.51	5.37	5.23	5.08	4.93
1400	6.72	6.61	6.49	6.37	6.25	6.12	5.99	5.85	5.71	5.57	5.42	5.27	5.11
1450	6.95	6.84	6.72	6.59	6.48	6.34	6.19	6.06	5.91	5.77	5.61	5.46	5.29
1500	7.18	7.07	6.94	6.81	6.70	6.55	6.40	6.27	6.11	5.97	5.80	5.65	5.47
1550	7.41	7.29	7.16	7.03	6.91	6.76	6.61	6.47	6.31	6.16	5.99	5.83	5.65
1600	7.64	7.51	7.38	7.25	7.11	6.97	6.82	6.67	6.51	6.35	6.18	6.01	5.83
1650	7.87	7.73	7.60	7.46	7.32	7.18	7.02	6.87	6.70	6.54	6.37	6.19	6.01
1700	8.09	7.95	7.82	7.67	7.53	7.38	7.22	7.07	6.89	6.72	6.55	6.37	6.19
1750	8.31	8.17	8.03	7.88	7.74	7.58	7.42	7.26	7.08	6.90	6.73	6.55	6.36
1800	8.53	8.39	8.24	8.09	7.94	7.78	7.62	7.45	7.27	7.08	6.91	6.72	6.53
1850	8.74	8.60	8.45	8.29	8.14	7.98	7.81	7.64	7.45	7.25	7.08	6.89	6.69
1900	8.95	8.81	8.65	8.49	8.34	8.17	8.00	7.82	7.63	7.42	7.25	7.06	6.85
1950	9.16	9.01	8.85	8.69	8.53	8.36	8.19	8.00	7.81	7.60	7.42	7.22	7.01
2000	9.30	9.20	9.05	8.89	8.72	8.55	8.37	8.18	7.99	7.79	7.59	7.38	7.17
2050	9.54	9.38	9.22	9.06	8.89	8.70	8.53	8.34	8.14	7.94	7.74	7.52	7.31
2100	9.72	9.56	9.39	9.32	9.06	8.86	8.69	8.50	8.29	8.09	7.89	7.66	7.45
2150	9.90	9.74	9.57	9.40	9.23	9.02	8.85	8.66	8.45	8.24	8.04	7.80	7.59

(Concluded on Data Sheet. No. 311)

Radiator Foundry to Use Iron Molds

According to Estimates Prepared by the Inventor It is Possible to Produce 10,000,000 Feet of Radiation Annually With the Aid of 24 Machines and a Force of 50 Men

A PATENT has been granted Carl P. Herd, Kewanee, Ill., for a permanent mold designed for the production of radiator sections. Several molds, one of which is shown in Fig. 1, were prepared at the plant of the Davenport Foundry & Machine Co. and a number of sample radiator castings poured in them in what is claimed to be a perfectly satisfactory manner. The inventor states that his process will overcome the difficulties found in molding with sand, eliminate the necessity of providing skilled labor and increase production. To demonstrate his ideas, he has prepared plans and estimates for a foundry capable of turning out approximately 10,000,000 feet of radiation a year. This is to be accomplished by the aid of 28 molding stands and a total operating force of 50 men.

In this ideal foundry there will be no sand, therefore there will be no need of sand handling equipment, no overhead machinery, and no store room of belts, gears, pulleys and other expensive repair parts.

The sequence of operations from the coreroom to the test room will be as follows: The cores will be loaded on cars holding enough for a day's run and placed conveniently for the men closing the molds. Extra cars can be loaded one day for the next day's run and placed in position during the night.

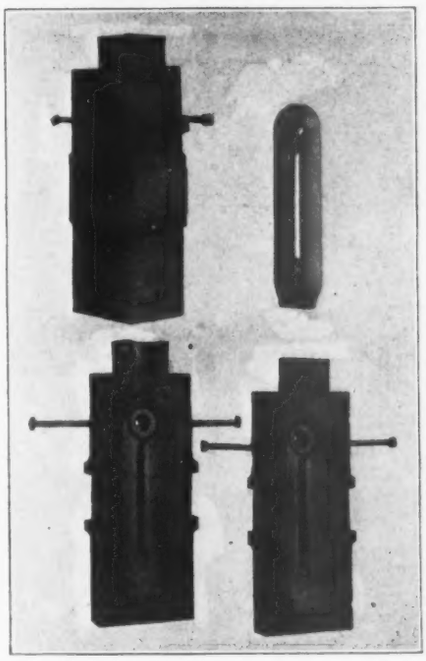


FIG. 1—SHOWING OUTSIDE AND INSIDE OF PERMANENT MOLD, ALSO TYPE OF CASTING PRODUCED IN IT

It is proposed to have one man for each machine. His duties will be to set cores and remove the casting after the mold is poured. Having knocked off the gates, he will hang the casting on a hook conveyor which will carry it in turn to the core sand knocker, the cold blast, and the annealing furnace. The mold will remain open four minutes, giving him ample time to perform these duties and also set the core for the next casting.

One air valve operator will have charge of six machines. He will be located in a pulpit high enough to oversee the different operations. After each core is set he will close the mold and swing it to a perpendicular position ready for pouring; after the mold has been poured, he will open it to remove the casting and prepare it for the next one.

Ten men will be required to pour the molds. Each man in turn will run a ladle hanging from a monorail up to the cupola, fill it with iron and pour such molds as he is instructed.

There are a number of details to be worked out yet but most of the operations are definitely fixed. The machine shop work on each mold will

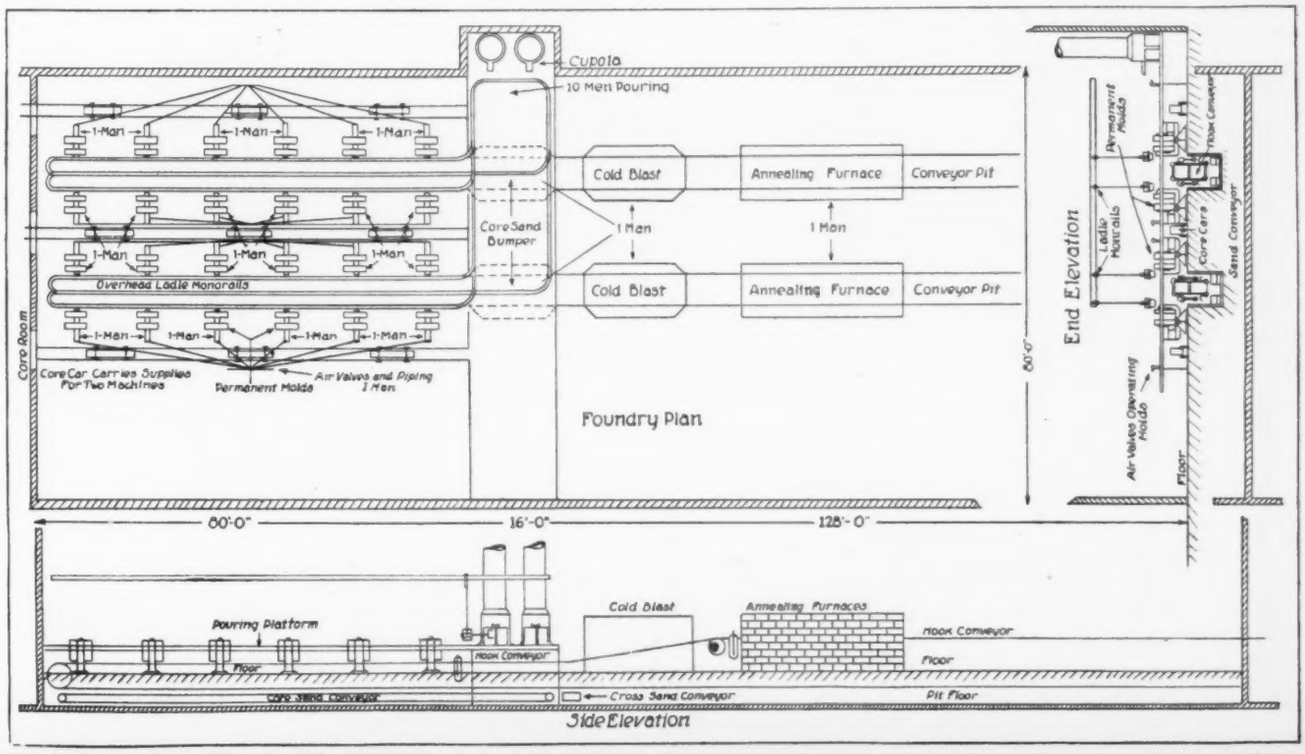


FIG. 2—FLOOR PLAN, SIDE AND END ELEVATION OF FOUNDRY EQUIPPED WITH PERMANENT MOLDS FOR THE PRODUCTION OF RADIATOR CASTINGS—THIS INSTALLATION IS ESTIMATED TO BE CAPABLE OF TURNING OUT 10,000,000 FEET OF RADIATION ANNUALLY

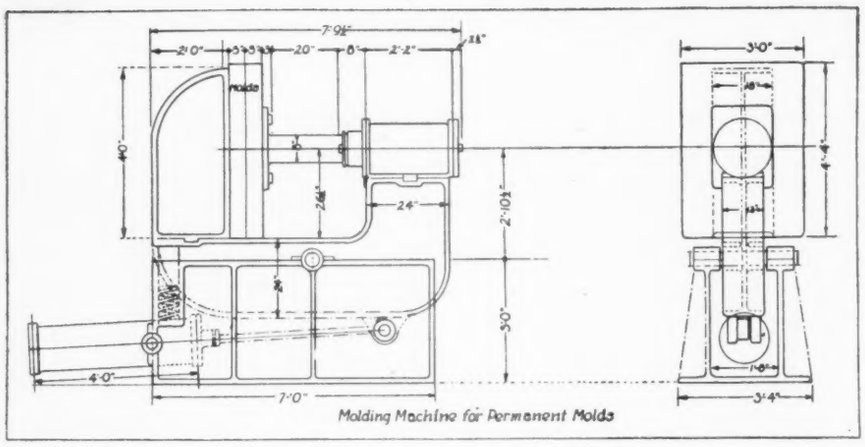


FIG. 3—ONE OF THE MACHINES WHICH PICK UP THE MOLD AND HOLD IT IN A VERTICAL POSITION FOR POURING

consist of facing the back and joint and fitting blocks in the slots at the sides. Two pins will be used for bringing the two half molds into proper alignment. The pins will be stationary but one of the pin holes will be adjustable in order to make allowance for possible shrinkage difference in the two halves of the mold. The lateral core prints will be reamed out in order that the core may hang true and plumb.

In sand molds for radiators, the chaplet is rammed up with the pattern and therefore the head appears outside the casting. It must be chipped off and if the stem has not fused with the heat of the molten iron, a leak develops which requires calking. With the permanent mold, the position of the chaplet will be reversed, the head will be in the core and remain on the inside of the casting. Furthermore, it is said lighter chaplets will suffice because the castings will be poured in a vertical position.

The Lewis Foundry & Machine Co., Pittsburgh, recently started its new 30-ton open-hearth acid furnace and is now making steel and alloy rolls. It is also making a more extensive line of steel castings than formerly.

Female Workers in British Foundries

A REPORT recently issued by the British committee on women in industry devotes considerable space to the services rendered by women in foundries and outlines what it believes will be the kind of work to which women will be confined in the future in British foundries. Most of the testimony on women labor in the report was submitted by the British National Light Castings Iron Foundry federation. This federation embodies about 80 foundries in its organization all of which produce mainly stoves, grates and ranges.

Prior to the war approximately 600 women were employed by the federation and they were confined largely to foundry work of a light nature such as coremaking, enameling, blacking, scouring, etc. As the war thinned out the ranks of the men in the foundries, more women were gradually hired and the scope of their work amplified, until it came to include molding, common labor, fitting, disk grinding, in fact anything which they were able to do. By Nov. 11, 1918, the number of women in the foundries of the federation had reached a total of 4000.

It is the consensus of opinion among British foundrymen that women show great aptitude for training, but that they require much more careful supervision than men, and thus entail a larger overhead expense. They can be employed profitably on such operations as coremaking, light machining, gaging, assembling, painting, etc., but they are absolutely unqualified for molding, dressing, grinding and other heavy work around the foundry floor. It is also agreed that the payment of the same wages to men and women engaged on the same class would make the employment of the latter prohibitive. In one foundry, which produces heavy gray-iron castings, women before the war received a wage of between 12 and 15 shillings a week while the men, taking all classes on an average from skilled to labor, received 32 shillings. At that time wages were apparently regulated only by the law of supply and demand. During the war additional women were hired at this foundry until they exceeded the men in number. At the order of the British ministry of munitions the average wage for women was fixed at two pounds a week, while the men receive three pounds, 10 shillings. In many cases, separate shops have been set apart for the women.

By the phrase "adapting work for women" is generally meant installing machinery in the effort to make the work as mechanical and as much of a repetition nature as possible. With the benefit gained from a low wage,

WOMEN TRANSPORTING MATERIAL AT A LARGE BRITISH FOUNDRY

it is in this manner that British foundrymen are able to profitably employ women.

According to the testimony of John King, chairman of the National Light Castings Iron Foundry federation, "the loss of female labor would not actually cripple the industry, but it would seriously affect it. The British foundry is being forced to face severe competition from Germany and America, especially the latter, and export trade is absolutely necessary to its existence.

Steel Castings in Brazil

The Tropenas Converter Co., 2243 Nostrand avenue, Brooklyn, N. Y., has completed the installation of a steel casting plant at Rio de Janeiro for the Brazilian war department. The original intention of the Brazilian government in ordering the steel casting unit was to use it for making shells; for at that time its active participation in the world war was considered quite probable. The Tropenas company supplied a full shell making outfit but the armistice was signed before its installation and therefore there was no further use for it.

The engineer in charge, E. Roubieu, was a man of resource and did not propose to see the plant stand idle because there was no war to keep it going. He made a survey of the work coming under the jurisdiction of the Brazilian war department with the object of getting permission to cast some articles that had previously been forged.

A collection of the first castings made is shown in Fig. 1 and a general view of the foundry in Fig. 2. In addition to the castings there were also produced chisels and hammers which after suitable heat treatment were used to chip the fins and gates off the other castings. The entire proceeding seemed quite astonishing to the people in that country and long articles were published in the Rio press on the subject. The Tropenas company is also installing a steel-casting plant for the Brazilian naval department and expects to have it in operation in a short time.

FIG. 1—TWO BLOWS OF TROPENAS STEEL CASTINGS MADE WITH A CONVERTER AT THE ARSENAL DE GUERRA DE RIO DE JANEIRO, BRAZIL

FIG. 2—GENERAL ARRANGEMENT OF STEEL FOUNDRY OF BRAZILIAN GOVERNMENT

Scale on Malleable

By H. E. Diller

Question—What will take packing scale from the walls of a cored hole in a malleable-iron casting, and what causes this scale?

Answer—Packing will stick to malleable iron castings in the anneal if the castings are not thoroughly cleaned, or if the packing is too highly oxidized. The remedy in the first place would be to see that the castings are all thoroughly cleaned. Should the trouble be due to the packing the remedy would be found in adding cast-iron turnings to the packing—about 25 per cent of the bulk to start with. If this does not bring the castings out free from scale a little more turnings should be added.

The best way to clean such a hole would be with sandblast or by pickling. If a sandblast is used it will be necessary to secure a special nozzle to reach into the hole. If pickling is tried use hydrochloric acid diluted with an equal amount of water. You may find it necessary to heat the acid somewhat. As soon as the scale is eaten away from the casting remove it from the acid and wash it in hot, clean water. The aim, however, should be to thoroughly clean your casting in the hard iron and so regulate your packing that it would not stick to the casting after being taken from the anneal. If the hole is small and can be readily stopped up, it might pay to do this so that no packing could get into the hole. Whatever is used to plug the hole should be easily removable.

The Franklin Soapstone Corp., Ltd., Vancouver, B. C., has ordered a Greaves-Etchells type furnace from the Electric Furnace Construction Co., Philadelphia.

Better Steel Castings Are Required

Experience Has Led Buyers to Expect Quality in the Product of Steel Foundries—Heat Treatment Increases the Strength and Ductility of the Metal

BY H. A. NEEL

THE subject of this discussion was chosen because I believe there is no material entering into machine construction at the present time about which so many misconceptions are current as the steel casting. The knowledge on the subject possessed by many designers is limited to that acquired from an engineer's handbook or from the current technical magazines. The fetish of the modern engineer is efficiency—maximum return at minimum cost, and ultimately all manufacturing processes are co-ordinated to yield that result. Therefore let us discuss the case of the steel casting from that angle, but let me state at this point that I am presenting a brief only for the quality steel casting made by the most approved methods.

I have heard an engineer define a steel casting "as a collection of holes loosely united to each other by thin webs of metal", and I am sorry to say that the description was apt as applied to some such castings. Porousness in castings arises from three causes: *First,* occluded gases in the molten steel which are released as the metal passes through the pasty stage prior to solidification and give rise to minute holes usually described as oxidation; *second,* from the gases generated by the moisture or bonding substance in the sand, which are unable to escape through the sand before the metal solidifies and give rise to the condition known as blow holes; and *third,* from genuine shrinkage at points where insufficient risers have been provided to feed the castings. The average layman classes all these defects under the one name of blow holes although they arise from three distinct causes.

Preventing Defects

Oxidation can be prevented by careful attention to the analysis of the metal and its physical condition in the furnace. Blow is eliminated by proper drying and venting of the molds. The effects of true shrinkage will be eliminated in the casting through correctly placed chills and risers and proper methods of gating. The only safe way to ascertain whether this problem has been met is to hold up production until one or more sample castings are made and sawed in pieces to allow an examination of the inside for shrinks. Sometimes as many as six or eight different arrangements of gates, risers and chills will be tried before the foundryman is entirely satisfied. Of course, such practice cannot be followed on small jobbing orders but its application is essential on orders involving large quantities to insure against loss by hidden defects.

The foregoing defects may be classed as mechanical; their effect is to lessen the strength of castings by decreasing their effective cross-sectional area. Provided we are able to eliminate trouble from all these sources, we can get the benfit of the full cross section of the metal.

The war experience, through which we have just passed, has been of great value in educating the foundrymen to meet rigid physical specifications. Before the war, orders carrying iron-clad specifications were accepted by few foundries and only then at high prices. Now the testing of our product has been reduced to routine and customers are encouraged to furnish full information and specifications on their require-

A paper read at a recent meeting of the Detroit section of the Steel Treating Research Society. The author, H. A. Neel, is metallurgist of the Michigan Steel Castings Co., Detroit.

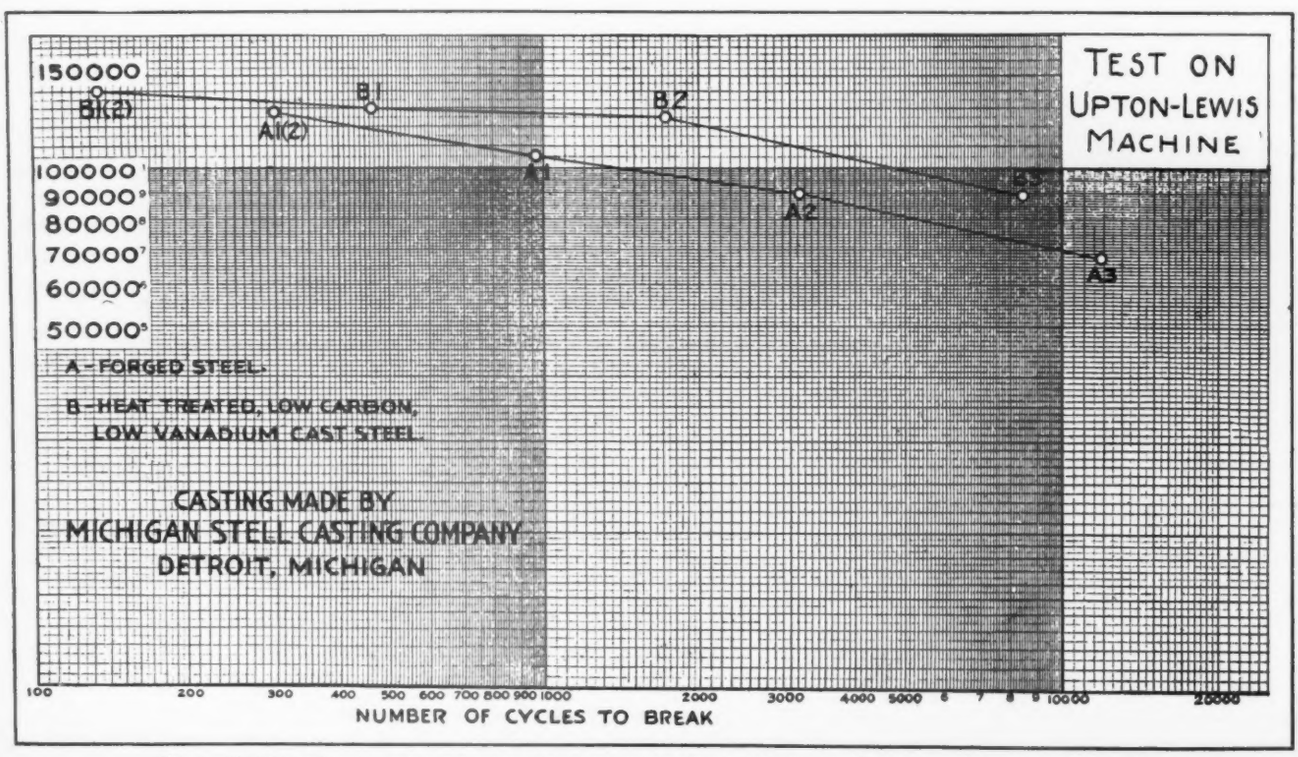


FIG. 1—FATIGUE BENDING TESTS OF STEEL MADE ON UPTON-LEWIS MACHINE FOR THE INTERNATIONAL MOTOR CO.

ments in order that intelligent service may be rendered them. An example of the way this collaboration works out is found in the manufacture of high-pressure steam fittings. By testing these castings at the foundry under hydraulic pressure, all defectives are eliminated and the customer is insured against having to tear down the assembled unit to remove a leaky fitting. Probably 10 years of peacetime effort would not have resulted in as material an advance in securing high physical results and uniformity of product as came from our brief war experience.

During the war period the demand for steel castings was so tremendous that even with greatly increased facilities the founders could not keep pace with requirements. The disposal of this increased foundry capacity resulting from the war's requirements is now a question. Obviously purely peace time demands will call for only a moderate increase over prewar consumption if steel castings are to be confined to their prewar uses.

As a matter of fact, some of those uses no longer exist, as the inability of truck and tractor manufacturers to obtain steel castings forced them to redesign their product to eliminate castings and substitute stampings or to replace steel with malleable castings of heavier section. Also by reason of improvements along machine molding and finishing lines in the modern plants, it will be possible to turn out certain kinds of castings at a very low cost and with small margin of profit. This means that some foundries will starve to death unless new fields be found for their product. Let us examine some of the fields which are logically open for invasion.

It seems strange that with the great advances which have been made in the manufacture of alloy steels and their heat treatment, the activities along these lines have been confined so largely to forged and rolled products. John Howe Hall in his book, "The Steel Foundry," gives some very interesting data on effects of heat treatment on the properties and structure of cast steel but efforts to apply his theories have been limited in their scope. It may be that the engineer or metallurgist has felt that steel castings were so undependable that special treatment was wasted effort; or more probably the casting manufacturer was at fault by reason of his failure to maintain scientific control of his product and render assistance to the customer in solving his steel-casting problems. In fact even yet there are a few foundries which operate by rule of thumb on analysis and sell their product without first subjecting it even to an annealing treatment. Fortunately for the good of the trade in general, such concerns are being rapidly forced to adopt better practices.

The reliable plain carbon-steel casting of today has been brought to a point where the problems of manufacture are the purely mechanical ones such as proper heading to feed shrinkage, proper filleting and bracketing to avoid cracks, and proper temperature and pouring conditions to avoid misruns and cold shuts. It is therefore time to work for better physical properties than those found in a low carbon casting, straight annealed. Part of the writer's time for the last three years has been spent on work along these lines and the possibilities revealed are most encouraging.

The problems involved in the heat treatment of steel castings are very similar to those encountered on forgings insofar as warping and cracking are concerned. The question of proper temperatures cannot be met simply by applying indiscriminately the ranges found suitable to forgings of similar analysis. As a matter of fact, there is a certain inertia toward heat treatment exhibited by castings, the overcoming of which requires force in the shape of higher temperature or longer soaking, than is needed to accomplish the same result in forgings. For every grade it is necessary to conduct a careful series of tests to determine the desirable quenching medium, quenching temperature and drawing temperature. The aim is always to get a steel which will give desirable properties without a complicated heat treatment.

The simplest heat treatment known is to vary the ordinary straight annealing process by air cooling from above the critical range and the drawing back to a temperature from 800 degrees Fahr. to 1200 degrees Fahr., depending on the properties desired. Effect of this treatment using 1000 degrees Fahr. draw back is shown in Table I.

The application of this simple treatment increased the working strength of the steel more than an addition of 17 per cent of carbon, without sacrificing very much of the ductility.

In general we are able to benefit low-carbon steels by an addition of from 5000 to 8000 pounds per square inch in elastic limit and ultimate strength with small loss of ductility and very good machining properties Much of the ordnance steel made in the last two years has been treated this way. We have found that steels high in manganese yield particularly good results on air quenching while the vanadium steels respond only slightly to the treatment. The benefits are not confined to increased resistance to slowly applied loads but confer high shock and fatigue resisting properties as compared to straight annealed steel.

The next logical step in heat treating is a simple water quench and redraw. This has the disadvantage of not being applicable to extremely complicated sections because of the severity of the quenching strains. A careful study of design will often enable the foundryman to suggest modifications which will retain the essential characteristics of the piece and still permit of water treatment. An example of properties obtained by water quench with 1250 degrees draw on a sample of 0.28 per cent carbon, 0.70 per cent manganese steel are elastic limit 48,750 pounds per square inch, ultimate strength 77,450 pounds per square inch, elongation 30 per cent, and reduction of area 46.3 per cent. The comparative qualities of the same bar straight annealed were elastic limit 35,000 pounds per square inch, ultimate strength 70,250 pounds per square inch, elongation 24 per cent, reduction of area 30.8 per cent. In this case it will be observed that every property was benefited by treatment, the most marked improvement being in the elastic limit, which showed an increase of 39 per cent without corresponding sacrifice in ductility. A bar ½ x 1 x 6 inches treated as just stated stood a cold bend through an angle of 120 degrees around a 1-inch diameter without any sign of cracking. Repeated experiments have shown that a water quench with draw close under the critical range always gives a marked increase in the ductility of the steel. The effect on the Brinell hardness is an increase of about 30 points over that of the straight annealed steel.

While heat treatment on plain carbon-steel castings yields an improvement of from 20 to 50 per cent in strength, together with increased shock and fatigue resisting property, the really worth while results are achieved on simple

Table I

Physical Tests of Treated Steel

Analysis C.	Analysis Mn.	Elastic limit	Ultimate strength	Elong., per cent	Reduction of area, per cent	Treatment
0.27	0.87	45,000	80,250	20	27.5	Air quench, drawn at 1000 degrees
0.27	0.87	26,400	73,980	22	34.4	Straight anneal.
0.44	0.83	41,400	83,700	22	29.2	Straight anneal.

alloy steels where the strength may be doubled and sometimes tripled by judicious treatment. This is done at an increase in cost of from 4 to 7 cents per pound. In parts where high strength and minimum weight are desired it is possible to substitute a heat treated alloy casting for the ordinary carbon-steel casting at an actual saving in cost; that is if you replace a 20-pound casting worth 14 cents per pound by a 12-pound casting at 21 cents per pound you have a net saving of 28 cents per piece. In addition you have reduced weight and added strength.

To meet the varying requirements of truck, tractor, and machinery castings there has been developed a series of steels with yield points from 30,000 pounds per square inch up to 110,000 pounds per square inch, the higher strength has been obtained without undue sacrifice of machining qualities. The range from 30,000 to 50,000 pounds per square inch yield point is met with carbon steels. The simplest alloy used meets a specification requiring an elastic limit 50,000 to 55,000 pounds per square inch, ultimate strength 80,000 to 90,000 pounds per square inch, elongation 16 to 20 per cent, and reduction of area 30 to 40 per cent. The cost of this alloy is so little above regular steel that it is negligible.

From the foregoing type, at a gradually increasing cost, we rise to the highest strength alloy we are regularly producing with minimum yield point of 100,000 pounds per square inch. Two typical tests of this steel are as follows:

Elastic limit	Ultimate strength	Elongation per cent	Red. area, per cent
107,440	124,880	18	47.9
115,600	131,800	14	57.3

A complete range of steels can be furnished in between the two types cited above and the strength can be increased to a much higher point but with a sacrifice of ductility.

Very probably these results are in no way extraordinary to the engineers who are accustomed to think in terms of rolled or forged steel but they are rather out of the ordinary as applied to castings. It has been customary where strength greater than 60,000 pounds per square inch was required and the use of the piece precluded increasing the section to specify a forging. Sometimes this was done at a very heavy expense for dies and at high machinery cost due to the difficulty of making complicated sections in a drop forging.

The high grade steel casting manufacturers are now in a position to challenge this practice of relegating their product to the background when high tensile and fatigue properties are called for. Properly forged sections undoubtedly possess the advantage of a fibrous structure not found in castings, but this advantage holds only so long as the stresses are in the general direction of the fibre. Cross grain strength in the same piece is much lower than in a casting of similar analysis and treatment. Very often the steel in a forging will be so worked that cross grain will exist at a vital point or it may be that stresses are so distributed that some must pull across the grain. In either case the steel casting with its uniform grain structure will surpass the forging in strength.

Table II shows what has been obtained in the way of physical properties on a commercial scale. In addition to these there are quite a few alloys that we have started to investigate but which have not proved commercial as yet. The field is very broad, but enough has been done to give the engineer the right to call for high physical properties in the steel castings he buys.

These statements are by no means to be construed as a blanket challenge to steel forgings. The point I am endeavoring to bring out is that many of the apparent superiorities of forgings do not necessarily hold in commercial practice. Neither does the time honored prejudice against steel castings in uses where they are subjected to fatigue hold in actual tests. Samples cut from cast alloy steel axles tested against similar samples from a chrome-nickel forged axle in an Upton-Lewis machine showed the cast steel of superior fatigue resisting properties, as indicated in Fig. 1. Tests to destruction on full sized axles of identical design bent the castings while the forging broke.

As a matter of fact, the manufacturer should welcome the high grade steel casting as a valuable adjunct rather than a competitor of forgings. On quantity orders of simple design, it is impossible for the casting to compete very seriously with the forging. But in development of new models where production is limited and die expense must be amortized over a few hundred pieces, the steel casting is the logical material to use.

Significantly a certain parts manufacturer while spnding upwards of $100,000 in advertising his axles with emphasis on the fact that they are forgings, has been trying out cast axles and has hundreds in service without a single failure reported. This case is typical of the attitude of many firms. We have cast steel crank shafts, connecting rods, and other vital motor-car parts in use. The whole problem is still embryonic, but preliminary results are surely encouraging. My own work has been comparatively slight, but has shown me tremendous possibilities for steel foundrymen.

Table II

Physical Tests of Carbon and Alloy Steels

Kind of steel	Elastic limit	Ultimate strength	Elongation, per cent	Reduction, per cent	Remarks
No. 1 Steel, straight annealed, oven cooled	34,000	68,000	31.0	41.9	Irregular silky fracture
No. 1 Steel, straight annealed, oven cooled	33,120	65,000	26.0	35.7	Irregular silky fracture
No. 1 Steel, straight annealed, oven cooled	35,030	64,500	26.0	38.8	Irregular silky fracture
No. 1 Steel, air quenched and drawn	39,000	77,550	26.0	37.3	Irregular lam. fracture
No. 1 Steel, air quenched and drawn	42,250	75,000	27.0	37.3	Irregular lam. fracture
No. 1 Steel, water quenched and drawn	48,750	77,450	30.0	46.3	Irregular silky fracture
No. 1 Steel, water quenched and drawn	46,300	76,150	24.0	42.0	Irregular silky fracture
No. 3 Steel, heat treated ternary alloy steel	55,250	86,250	22.5	32.8	Irregular lam. fracture
No. 3 Steel, heat treated ternary alloy steel	58,925	92,925	20.0	28.8	Irregular lam. fracture
No. 3 Steel, heat treated ternary alloy steel	55,000	97,375	20.5	37.3	
No. 4 Steel, heat treated ternary alloy steel	72,500	98,125	22.5	39.1	Silky irregular fracture
No. 4 Steel, heat treated ternary alloy steel	68,400	96,900	21.0	40.1	Silky half cup fracture
No. 6 Steel, heat treated ternary alloy steel	76,020	99,740	22.0	30.0	Silky half cup fracture
No. 6 Steel, heat treated ternary alloy steel	81,500	102,000	23.0	48.0	Silky half cup fracture
No. 6 Steel, heat treated ternary alloy steel	84,000	103,800	21.0	47.0	Silky half cup fracture
No. 7 Steel, heat treated quarternary alloy steel	99,675	120,675	17.5	31.5	Irregular lam. fracture
No. 7 Steel, heat treated quarternary alloy steel	107,440	128,880	18.0	47.9	Half cup silky fracture
No. 7 Steel, heat treated quarternary alloy steel	115,600	131,800	14.0	37.3	Half cup silky fracture
No. 7 Steel, heat treated quarternary alloy steel	141,500	153,900	10.5	28.7	Half cup silky fracture

No. 1 Steel is low carbon, normal manganese steel. No. 3 Steel is low carbon, high manganese steel. No. 4 Steel is low carbon, high nickel steel. No. 6 Steel is low carbon, vanadium steel. No. 7 Steel is low carbon, chrome vanadium or chrome molybdenum steel.

Study Common Aluminum Alloys

A Discussion on the Relative Merits of Various Aluminum Alloys Used for Casting Purposes — The Same Alloy is Frequently Found Masquerading Under Several Names

BY ROBERT J. ANDERSON

PRACTICALLY every aluminum foundry superintendent and nearly all metallurgists in the aluminum industry have spent a great deal of time investigating new aluminum alloys. While many excellent alloys have been developed the experience of the foundry interests, government bureaus and skilled metallurgists with a large number of the new alloys announced has been disappointing. It is the purpose of this report to offer a brief account of experiences with certain types of light aluminum alloys brought forth within the past few years. A short discussion of the various types of successful commercial alloys is included for purposes of comparison, and reference. Tests made on a number of so-called secret alloys demonstrated that many of the claims made were not tenable. Some of these alloys have no value whatever, in the opinion of the writer, and others, if used for vital parts in engineering structures would constitute a menace to public safety. The composition of a number of typical alloys of aluminum is presented in the accompanying table. No one of these alloys tested has shown properties better than the ordinary commercial alloys, and usually the properties are not so good. Unscrupulous promoters are not inclined to furnish chemical analyses since their alloys are "secret."

On the other hand, some honest, but misinformed promoters are unable to furnish accurate information, since they have little idea of what they are trying to do. How far short of the claims made for them some of the alloys fall is shown by a comparison of their properties and the purposes for which they were intended to be used. The most striking example is that found in alloy No. 4 in the accompanying table. The chemical analysis shows that this alloy is just an impure aluminum and could not possibly be used as a casting alloy for vital parts of a motor since it is altogether too ductile and weak. A discussion of the other alloys appearing in the table may be advisable for the purpose of demonstrating their exact nature. This discussion follows:

Alloy No. 1.—The chemical analysis shows that this is the well known high-zinc ternary aluminum-copper-zinc alloy.

Allow No. 2.—The ultimate strength of this alloy was given as 30,000 pounds per square inch and the specific gravity was stated to be very low. Tests showed that the claims were not founded on facts. The analysis proves that it is similar to alloy No. 1 and consequently cannot have the low specific gravity alleged.

Alloy No. 3.—This alloy was probably made from impure scrap.

Alloy No. 4.—The characteristics of this alloy have already been referred to.

Alloy No. 5.—This alloy was claimed to have "remarkable properties due to elements scientifically combined." It does not have properties appreciably different from those of a simple binary aluminum-copper alloy with 6 per cent copper.

Alloy No. 6.—The chemical analysis given in the table would indicate that the properties were not much different in sand castings from those of commercial No. 12.

Alloy No. 7.—This alloy may be regarded as a quaternary aluminum-nickel-copper-cobalt alloy, and is equivalent to a 12 per cent copper-aluminum alloy.

Alloy No. 8.—The chemical composition was found to be as given in the table. The alloy is practically equivalent to a ternary aluminum-copper-zinc alloy containing 11 per cent zinc, 3 per cent copper, and the remainder aluminum.

Alloy No. 9.—This alloy is simply a binary aluminum-magnesium alloy.

For purposes of comparison and reference the following description of successful commercial alloys is included: There are a number of commercial binary aluminum-copper alloys. That known in the trade as No. 12 is the most widely employed. It contains roughly 92 per cent aluminum and 8 per cent copper. The only binary aluminum-manganese alloy finding extensive commercial application is that containing 1.50 per cent manganese, remainder aluminum. This alloy is used mainly for rolling sheets, but it is also used for die-castings. Few true binary aluminum-nickel alloys are now being made, and some of those claimed to be such are usually found to contain both copper and nickel. Simple binary aluminum-zinc alloys have been used with various percentages of zinc from 7 to 35 per cent, but information as to performance is exceedingly contradictory. The commercial tendency is away from the binary aluminum-zinc alloys, and when zinc is to be used the trade favors a ternary aluminum-copper-zinc alloy.

One of the most successful alloys of the ternary aluminum-copper-manganese type kind known, is used for casting and forging at the United States naval gun factory, Washington. It is made up to contain 2 per cent copper and 1.50 per cent manganese; the remainder aluminum.

Aluminum-rich alloys containing copper and small amounts of tin have been used for special casting purposes but as a rule they are no improvement over the ordinary No. 12 alloy. Ternary alloys of aluminum, copper and zinc are used widely for casting alloys and in general they may be divided into two classes: the high-zinc type and the low-zinc type. In both the copper content may be from 3 to 5 per cent.

Duralumin although not primarily a

Analysis of Various Aluminum Alloys

Alloy No.	Cu per cent	Zn per cent	Mn per cent	Ni per cent	Mg per cent	Fe per cent	Si per cent	Pb per cent	Sn per cent	Co per cent	Cr per cent	Al per cent*
1	3.15	25.46	Nil	Trace	Trace	0.24	0.22	.....	....	....	....	70.93
2	2.56	22.21	Trace	Trace	.....	0.54	0.38	.....	....	....	....	74.31
3	1.07	0.76	0.06	.....	.....	0.57	....	.....	....	....	....	97.54
4	0.25	Nil	0.10	Nil	0.56	0.47	0.40	Nil	0.59	....	....	97.63
5	3.09	Nil	0.38	1.23	Nil	0.70	0.38	Trace	....	....	0.21	93.01
6	5.63	0.57	Trace	1.90	.....	1.24	0.60	.....	....	....	....	90.06
7	10.28	Nil	.....	1.54	.....	0.57	0.28	Nil	....	0.40	....	86.93
8	9.73	3.00	0.18	0.76	Nil	0.56	0.35	.....	....	....	....	85.42
9	0.18	.....	Trace	.....	1.62	0.26	0.30	.....	....	....	....	97.64

* By difference.

Abstract of report prepared at the suggestion of D. A. Lyon, superintendent of the Pittsburgh, Pa., experiment station of the bureau of mines. Issued as a pamphlet by the bureau of mines. The author, Robert T. Anderson, is metallurgist for the bureau.

casting alloy has attracted considerable interest. It is composed of, copper 3.5 to 5.5 per cent; manganese, 0.5 to 0.8 per cent; magnesium, 0.5 per cent; aluminum, difference.

Strictly speaking, magnaliums should be described under a caption "binary aluminum-magnesium alloys," but the commercial magnaliums tend to be rather complex. Alloys of aluminum with magnesium in various amounts, either with or without other elements, have been used for both casting and rolling. As a rule the magnaliums are not as strong as the No. 12 alloy, have greater elongation and are more expensive.

Until certain properties of the present successful commercial alloys are more completely investigated, and foundry problems in connection with the manufacture of castings on a production scale have been solved, it would appear that foundry experimentation on new and untried alloys should be proceeded with on a scientific basis under the best laboratory conditions.

How and Why in Brass Founding

By Charles Vickers

Copper Castings for Use as Electric Terminals

We have experienced difficulty in making copper terminal castings for electrical purposes. The castings range in size from one-half pound each, up to 10 or 12 pounds. We are using oil for fuel and melt the metal in an open-flame cylindrical furnace. Kindly advise best mixture to use, and method of pouring and melting to produce a casting as nearly pure as possible.

When the copper is charged, instead of charcoal, use blocks of wood. Clean refuse will answer the purpose if desired. The fumes given off by the burning wood protect the copper while it is heating. Use the following flux with the wood: Sawdust, 2 pounds; soda ash, 1 pound; white sand, 1 pound; borax, 2 ounces; calcium chloride, 4 ounces. Dissolve the soda ash and calcium chloride in a little water; mix the sand, sawdust and borax; and add the water with the chloride and soda. Use about 1 per cent of this flux, added when the copper softens, before melting. This will protect the copper from excessive oxidation, and also will take care of the sulphur in the fuel. For carrying off the copper, loam-lined ladles are better than crucibles, as they retain the heat. Have them hot, and if crucibles are used have them red hot. Put the deoxidizer in the bottom of the ladle and pour the copper on top. Also have a layer of burning charcoal in the bottom of the ladle. When pouring, hold the charcoal back with a broad skimmer. Never skim copper clean, previous to pouring. Before pouring the copper from the furnace, pole it with hard wood saplings. Simply thrust the wood into the copper and keep pushing it in. When the copper lies quiet in the furnace, pour into the ladles. The best deoxidizer is silico-calcium copper, using 0.5 per cent. The copper should be hot when poured into the ladles, and if it has been well poled so that a sample ingot sets with a level surface, it will be only necessary to add 0.25 per cent of silico-calcium copper.

An alloy of magnesium 10 per cent and copper 90 per cent can also be used as a deoxidizer, but is not as effective in producing sound castings as the silico-calcium copper.

Overcoming Pinholes in Aluminum Castings

We lately have been experimenting with making aluminum griddles and frying pans, but the results were not entirely satisfactory. For our aluminum we used a mixture of 14 per cent zinc and 86 per cent aluminum. We also used scrap aluminum crankcases. The latter appeared to produce the best castings, but minute holes appeared on the surface of the castings when polished. These may have been due to the zinc chloride not having been

The scrap crankcases gave the best results because, most probably, they were composed of a different alloy to the one made up containing zinc. The crankcases were no doubt No. 12 alloy which is aluminum alloyed with approximately 8 per cent copper. It is not necessary to use a large amount of zinc chloride, as a piece the size of a hazel nut is enough for a pot of aluminum containing 50 pounds. These holes are also caused by pouring the aluminum into the molds too hot, by ramming the molds too hard, or by putting too low a head on the aluminum. There is no reason why the castings should not be satisfactory if an alloy of copper, 8 per cent, and aluminum, 92 per cent is used, and precaution is taken to see that the metal is poured at a temperature below 1350 degrees Fahr., for thin castings, and high sprues are provided.

Facts About Antimonial Lead for Die Casting

We note that antimonial lead appears to be much used for die-castings, and we would like to obtain the formula for this alloy.

Antimonial lead is a by-product of silver refining. It is refined and sold as a lining metal for bearings and for other purposes. Antimonial lead contains lead, copper, iron, arsenic and antimony. The standard alloy is the one containing 20 per cent antimony and impurities, and 80 per cent lead. This alloy is used as a base for making other alloys by adding soft lead to reduce the percentage of antimony.

A satisfactory alloy for die-casting purposes contains, lead, 87 per cent; antimony, 13 per cent. This alloy can be made by direct alloying of antimony with soft lead. The lead should be heated to a redness and the antimony dissolved in it. Some of the lead should be reserved for cooling.

Brittleness in Lead-Copper Packing Alloys

We have been trying to make a mixture of 50 per cent lead and 50 per cent copper for packing purposes, but have not been successful. We have been using 1 per cent sulphur to hold the lead in solid solution with the copper, but found the first cast sweaty and somewhat brittle. The second cast of the same metal, however, was much better in uniformity and lead retention, but it was still rather brittle, and there were blow-holes at the bottom of the ingot.

An alloy of half copper and half lead is always rather brittle, which condition is to be expected from the high content of lead, and the fact that it is not alloyed with the copper, but is merely held in suspension. The cop-

per assumes a condition of porosity so that the lead reposes in the cavities and is held like water in a sponge. This is the reason sulphur is used. Instead of sulphur some makers use galena, an ore of lead containing sulphur, and claim to get better results than can be obtained with sulphur. In the present case, on the remelt, it would be advisable to add plaster of paris when the metal is beginning to melt. This would assist materially in the retention of the lead.

The blow-holes on the bottom of an ingot are due to gases evolved by the iron of the mold. The brittleness of the product is to be expected, as it is always brittle. This can be remedied by increasing the copper. Usually less than 30 per cent of lead is found in successful alloys of this type.

Antimony and Bismuth

We have a number of sleeves to make about 4 inches outside diameter, 3½ inside, and from 7 to 9 inches long. About one-third of the lot is to be made of bismuth and the remainder of antimony. As we have never handled these metals before we would like to learn if any special difficulty will develop, and whether we can pour them in the ordinary way from crucibles into sand molds.

Antimony melts at 1150 degrees Fahr., bismuth at 512 degrees Fahr. The latter, therefore could be melted in an iron ladle, but a crucible is required for antimony. Bismuth ought to present less difficulty than antimony because of its low melting point, and it would be well to use great care in melting to obviate overheating the metal. Pour at as low a temperature as is consistent with the proper fluidity, use large feeders on top of the castings, and coat the molds with plumbago. Antimony is volatile; use charcoal as a cover and keep the temperature as low as possible; do not breathe the fumes as they are poisonous. As these metals are weak and crystalline the gates can be expected to crack off carrying part of the casting, also the risers will crack off, biting into the casting, and the castings will split. Cut the gates so they have a weak section just as they enter the casting; then they will break on this section. Do not taper the risers downward, otherwise they are suspended by the sand and pull pieces out of the casting. Make the risers straight and smooth with no flare at the top. Green sand cores are less rigid than dry sand cores, but if the latter must be used, make them soft, to give the metal opportunity to contract without splitting the casting. Carbon molds with green sand copes would produce good castings of these metals.

Plastic Material Sought for Brass Molds

We desire to make some brass and bronze castings and would prefer to make them in some plastic material instead of in a sand mold. We understand that such castings are being made and that they resemble castings made by the die casting process, but save the expense of dies and machines. Any information will be appreciated.

A plastic material such as mentioned would be a wonderful discovery, but it is not likely ever to be made, because this earth is lacking in the necessary materials. There is no such process in operation anywhere and the information in regard to the matter is not correct. The castings in question will either have to be made by the old fashioned sand process, or by the die casting method. We would suggest the sand process as this is generally well known, while the die casting method would require the services of an expert before operations could be commenced. The story regarding the plastic material for molding no doubt arose from the exploitation of amphibole for the purpose of making permanent molds. Amphibole is a variety of asbestos, but is inferior to the fibrous serpentine of Canada. It has been used for making molds, but fails to produce anything like the product of the die casting machine.

High Zinc in Aluminum Causes Unsoundness

We are having considerable trouble with aluminum castings which we are making from scrap automobile engine parts; old, light scrap and scrap ingot. The latter is supposed to be No. 12 ingot but it looks blue and white. The castings always shrink below and around the gates, and it is usually necessary to burn the castings no matter whether they are light or heavy. The heavier castings in addition shrink on the drag half. The top part is always right. The molds are made as for brass castings. Suggestions will be appreciated.

The shrinkage at the gates may be due to making them too small, and we suggest that the gates and the sprues be enlarged and that the latter be carried higher in order to give more pressure on the mold. No. 12 ingot should only be obtained from makers who are known to be reputable. The automobile scrap ought to make good castings as it is metal of good quality. The fact the castings shrink on the drag half of the mold and not in the cope side would indicate that the metal is loaded with zinc. It is possible that the ingot metal contains more zinc than it does aluminum. It would be advisable to have an analysis made. To attempt to alloy scrap metals without an analysis is poor business policy in days when the work of the chemist can be obtained so easily and inexpensively. It is very difficult to get heavy castings sound on the bottom when poured from aluminum containing 35 per cent zinc. If, in addition to this large amount of zinc, impurities such as iron and silcon are introduced through the medium of miscellaneous scrap, it becomes practically impossible to produce sound castings. The loss from this cause carries their cost far above that of castings made from new metals entirely.

Standard Trolley Wheel Bronze Mixtures

Please inform us which of the following mixtures is most suitable for trolley wheels, and why phosphorous should be used in No. 2, together with zinc. The mixtures follows

	Copper per cent	*Tin per cent*	*Lead per cent*	*Zinc per cent*	*15 per cent Phosphor copper per cent*
1...	92.00	*none*	6.00	2.00	*none*
2...	88.50	6.00	*none*	5.50	1.00
3...	92.00	6.00	*none*	*none*	*none*

No. 2 contains no phosphor copper, but instead 2 per cent of 5 per cent phosphor tin is used.

Of the three alloys No. 3 is the most suitable for trolley wheels, although some authorities think the tin higher than necessary. In the writer's practice 6 per cent tin was as high as ever used, and No. 3 alloy can be modified by deducting 2 per cent tin from the 6 per cent. What is considered a standard mixture for trolley wheels consists of copper 92 per cent; tin, 6 per cent, and zinc 2 per cent. Lead never should be present in a trolley wheel as it reduces the life of the wheel greatly. For this reason No. 1 alloy is entirely unsuited for this service, as it contains a high percentage of lead and no tin. Regarding the phosphorous content of No. 2 alloy, 1 per cent of phosphor copper would add 0.15 per cent phosphorous which is entirely too high for the amount of zinc it contains. If the phosphor copper is reduced to 0.10 per cent, and is added to the cold copper by being placed in the bottom of the crucible, in crucible melting, and is added just as soon as the copper is melted in open-flame furnaces, a better alloy will result. It is excellent practice to add this small amount of phosphorus to zinc bronzes.

Bill Risks His Life to Inspect a Sand Mine

BY PAT DWYER

ONE night not long ago I was sitting under the shade of my own vine and fig tree which is a poetic figure to signify that I was sitting before the stove toasting my toes. I was reading a thrilling romance, the principal scenes of which were laid in and around the Arctic circle. I was warm and snug and therefore could read with equanimity of the gallant fight our hero made across limitless miles of desolate snow and ice, with the Aurora crackling overhead and a worthy but healthy, hungry bunch of wolves behind him. He had given his last crum of brandy and his last splinter of frozen fish to the heroine whom he had rescued a few days previously from the hands of the

BILL WAS ALL DRESSED UP AND HAD NO PLACE TO GO

miscreant half breed. The great barren stretched away in front of him 300 miles cold and lifeless and he knew that he had two days' hard traveling before he could expect to see the cabin of his old trapper friend, Ba'tiste Trudeau. Considering his position, I was wondering how the author was going to bridge those two days and land him safe in the trapper's cabin when the door of my cabin opened and Bill came in.

I gave him a couple of chairs, one on which to sit and the other to rest his feet upon before I asked him to explain what fortunate chain of circumstances was responsible for the presence of his company and the pleasure I expected to derive from his visit. He said he had dressed to go see one of our celebrated movie heroes defy death in a thousand forms; but the baby refused to go to sleep and his wife would not go out and leave it crying. Since he was all trimmed up, he felt that he must go somewhere and that was what brought him to my humble domicile.

After he was comfortably settled and had his pipe lighted, he picked up the book which I had been reading. He glanced at a page here and there and then laid it down.

"I don't see," said he, "how any man can sit and waste his time reading such rubbish." I told him it was simply a matter of opinion. I preferred to sit by my own fireside and read a story instead of going down town to a movie house to see it on the screen.

"Just to prove it to you," I said, "let me tell you that the story I am reading is the same one that you saw at the Olympic last summer under another name and which you thought so wonderful and thrilling."

Seeing is Believing

"Just the same," said he, "what a man sees with his own eyes has more effect on him than anything he can read in a book or even hear of. Evidence secured through any of the five senses is more convincing than hearsay or what is read in books. Now f'rinstance, you have been in a foundry all your life and what do you know about sand? Or what do you know about from whence it comes, or how it is prepared?"

"Well," I said, "I have seen several sand pits where sand is dug out and I am sure I must have shoveled and rammed a million tons of it since that day long ago when an old molder showed me how to change hands and flirt the sand off the end of the shovel in a graceful curve. That old lad by the way, was an artist in his line. He would not clean his shovel with a piece of iron, not he, he would hunt around for an old soldier and then use the burnt end. My dear friend, I have handled so much sand, seen so much and to be truthful, swallowed so much, that now I can take a handful and by simply squeezing and looking at it tell you for what it is fitted."

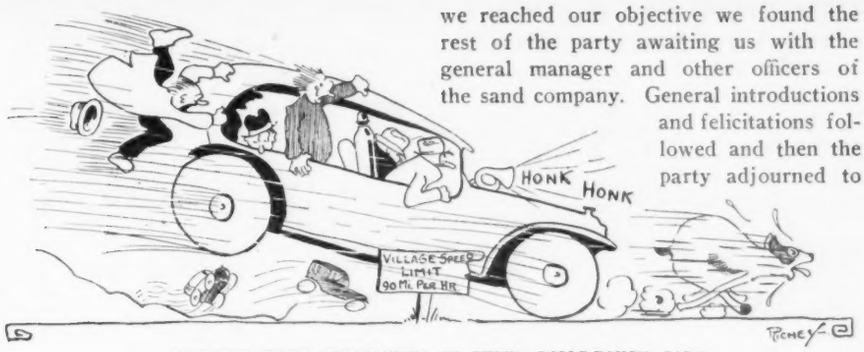
"That's only one kind of sand," said he, "did you ever see them preparing silica sand?" I told him I did not know what preparation was necessary outside of digging it and passing it through a fine screen.

"That is what I told the general manager one day," said he, "when he called me into his office and said we were going down next day to a place where they quarried silica sand. I asked him what he meant by 'quarrying sand.' He told me that this deposit which we were going to see was one solid mass of quartz crystals. He said that they blasted it out in huge blocks which were afterward passed through a crusher and disentegrator and finally screened into commercial sizes. I asked him what time the train left and he said we were going to drive it, it was only about 180 miles to the plant. He allowed that by hitting up a clip of 60 miles an hour or so we could do it nicely before dinner, visit around the plant for a few hours and get home again in time for supper. This program all depended of course on whether we had any acci-

HE DOUBTED THAT READING MAKETH A FULL MAN

dents. He cheerfully volunteered the statement that they had upset on one occasion and a couple of the fellows had their legs broken but the car had remained intact and had finished the trip under its own power, including a detour to a neighboring hospital where they left the injured men.

"On another occasion they had lost their way and had driven all night in the wrong direction. In the morning the party was all frozen stiff with the exception of the driver. The latter had a thermos bottle between his knees containing a supply of the elixer of life bestowed upon him by a pilgrim from Kentucky. When they started on the ride the evening before the thermos bottle had been full and the driver was vacant. In the morning the bottle was empty but the driver was—Oh well, he was still going strong. He looked up when the daylight became strong enough and recognized a large building near a noble river. He admitted that there was one point which caused him concern. When he had been there before there was only one group of buildings, but



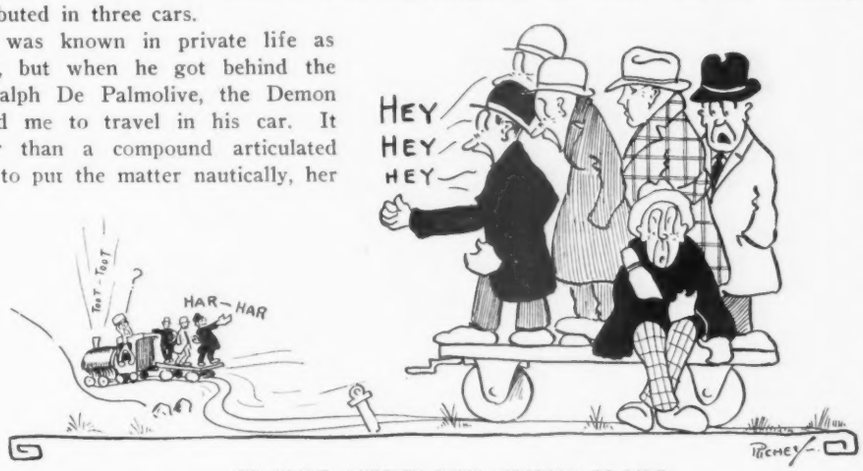
THIRTEEN WERE DISTRIBUTED IN THREE ROLLS-ROUGH CARS

now there were two before his very eyes."

Bill paused here and then resumed with a grin. "I found out afterward that he was only what our English friends call spoofing me or to use his own term 'I was just stringin' you along kid.'

"We got away in good time in the morning, about a dozen of us or 13, I forget which, distributed in three cars. The gentleman who was known in private life as the general manager, but when he got behind the steering wheel, as Ralph De Palmolive, the Demon Driver, kindly invited me to travel in his car. It was a trifle smaller than a compound articulated mallet locomotive or to put the matter nautically, her displacement was a little less than one of the ore carries on the Great Lakes. She could go some, too. To paraphrase our mutual friend Al Jolson 'I'll say she could.' Talking about Al and speed and all that kind of thing reminds me of the colored gentleman who was giving evidence at a murder trial in Cincinnati. He declared that he had heard two pistol shots. 'How far apart were these two shots?' said the lawyer. 'Oh, about so far,' said the witness striking his hands together at an interval of about four seconds. 'Now,' said the lawyer, 'be careful, remember you are on your oath. Where were you when the first shot was fired?' 'I was shining a gentleman's shoes in the Sinton hotel.' 'Where were you when the second shot was fired?' 'I was passing the Big Four depot.'

"I am not quite prepared to say that we equaled his indicated speed but we went around some hairpin curves on two wheels and hair pins would not have prevented my hair from standing up. As nearly as I can figure it out the driver went about 20 miles out of his way just to make sure that he would not miss any of these interesting turns. This circumnavigating stuff, while interesting, took time and as a result when we reached our objective we found the rest of the party awaiting us with the general manager and other officers of the sand company. General introductions and felicitations followed and then the party adjourned to the lee side of the big car where mysterious rites and ceremonies were performed. Each candidate as he passed the Big Mogul crooked his elbow and was told to say 'when' this was followed by a gurgling sound which typified the first brook to be crossed on the way to the promised land. A toast was pledged to the 'Sand man whose grit is equaled only by his hospitality.'



SIX HARDY ATHLETES WERE STRANDED IN PORT

"A tour of the quarry was made and the party noted the huge excavation where the solid rock is drilled and blasted out in some places to a depth of 65 feet. The marks of the drills were plainly visible in the vertical face and appeared to be about four feet apart. Our host assured us the intervals were eight feet. A tall member of our party with the luxuriant, flowing locks doubted this statement. He was a lineal descendant of doubting Thomas and would not be satisfied until he had scrambled over a pile of debris as high as a house to measure the distance with a two-foot rule.

"We saw the steam drills for boring the holes, the big steam shovel for loading the rock on the cars and then adjourned to a neighboring house where a chicken dinner awaited us. Oh, boy, that was some dinner. There was not a man that could button his vest at the conclusion of the meal but they all managed to waddle down, yes waddle is the word, to where two small flat cars attached to a narrow gage locomotive were waiting to carry the party to the crushing and drying plant.

By carefully careless maneuvering the heavy men of the party were segregated and loaded on the second car and then the coupling pin was removed. The whistle tooted, the bell rang and the locomotive and one car darted down the track about half a mile leaving the second car standing. Some would have been discouraged by an accident like that; they would have hoisted their red undershirt on the end of an oar and then curled up to starve until succor arrived. These hardy athletes were made of or filled with sterner stuff. They heroically drew lots and the losers got off the car and pushed until they caught up to the rest of the party. The burglar who had swiped the coupling pin and who as he admitted afterward, intended to take it home as a souvenir, was forced to place it where it belonged and the party reached the crushing plant without further adventure.

"We saw machinery for conveying, crushing and disintegrating the rock. We walked up an incline and saw where the sand and gravel was washed and passed through screens which automatically separated the material into various grades of fineness. We saw apparently inexhaustible piles of sand

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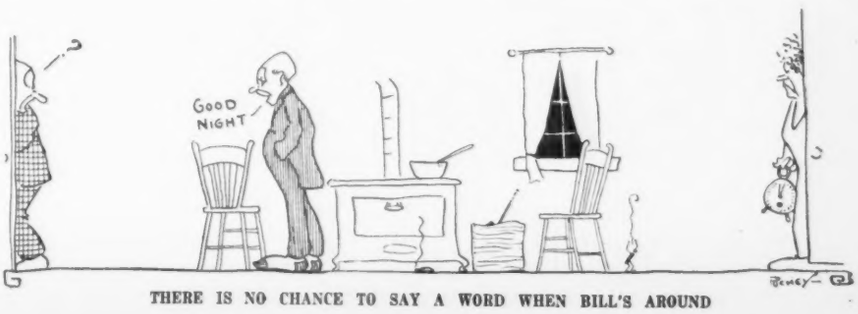


THERE IS NO CHANCE TO SAY A WORD WHEN BILL'S AROUND

Castings for Ship Construction--XIV

Molding the Type of Propeller Bracket Here Described Requires a Suitable Pit or Buried Flask — Cores are Built Up in Place at the Side of the Mold

BY BEN SHAW AND JAMES EDGAR

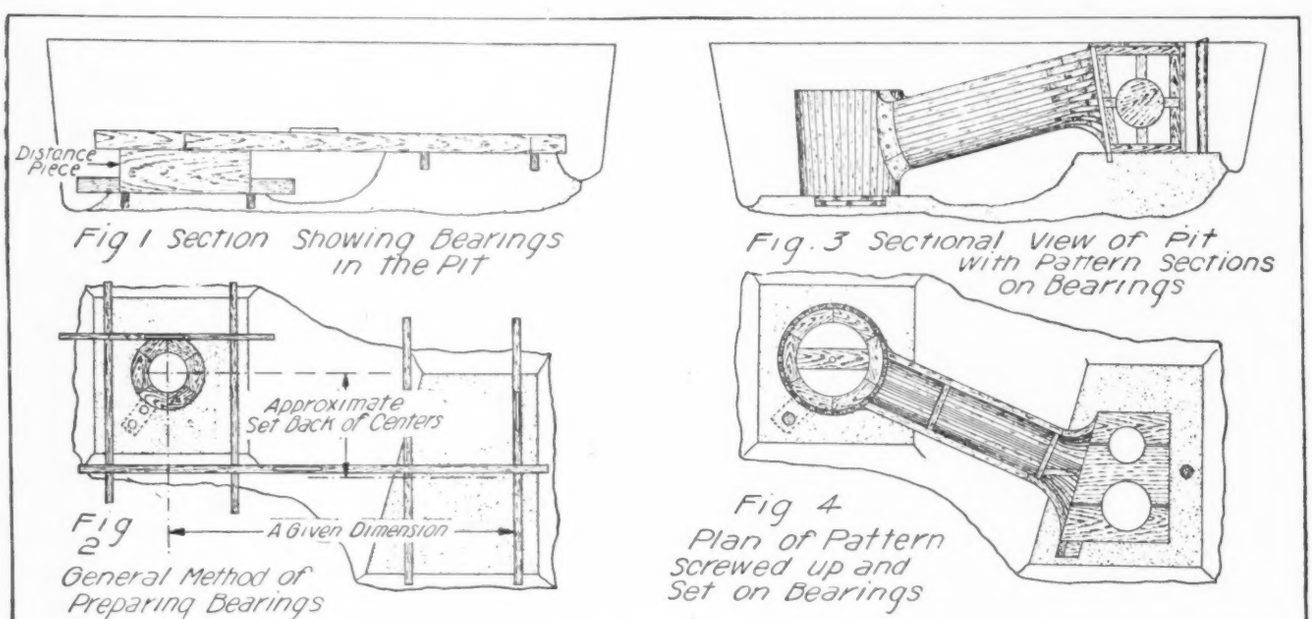
MOLDING methods used in making the type bracket described in the previous article, differ considerably from those outlined in preceding articles. This bracket offers great facilities for making cores with the mold, instead of in separate boxes. Steel foundries sometimes show preference for patterns which are as near to the requisite shape of the casting as possible and there are advantages to this principle. In the first place such patterns give the molder a clearer insight into what is actually required, and incidentally allow him to make any special allowance necessary for casting contraction during the construction of either cores or mold. The necessity for such allowance can be gaged better, as the true relationship between the cores and mold and the varying thickness of the metal are actually before the workman. It is also recognized in the foundry, that patterns from which cores can be made are likely to give a thickness of metal more nearly that which is required, and the rubbing to make loose cores fit is eliminated.

The design of many bracket castings are such, that if block patterns and separate coreboxes are used, extreme difficulty is experienced in obtaining the true shape between the relative parts of cores and mold. Not infrequently the foundry is called upon to remedy discrepancies of this kind which originate in the pattern shop and the result is not always what the designer intended. There is of course the disadvantage, that when cores and molds are made together the progress of the work is retarded. This is because fewer men can be employed on any given job, and also because cores made in this manner usually require longer to prepare.

Where the foundry is comparatively small, requiring a quick output, block patterns and separate coreboxes frequently are preferred. These permit the employment of more men and hasten the completion of each individual job. However, when block patterns are used there should be perfect agreement between pattern shop and foundry to allow the foundryman opportunities for molding the job in the way which he considers best. On the other hand a pattern made almost similar to the required casting, offers more room for initiative in the foundry, and is generally more acceptable to those who make the mold.

The most convenient method of molding the bracket here considered is governed by the position in which it is to be cast. Practically all such castings are cast with the boss vertical, and in this position the height from the bottom of the boss to the top of flask center is so great, as to make it impractical to use a roll-over flask. Some foundries possess large boxes or flasks which are bedded into the foundry floor with the top flanges flush. These are ideal for molds for castings similar to the one under consideration. If such flasks are not installed, then a pit must be made in the foundry floor, deep enough to allow the preparation of bearings and to bring the upper surface of the pattern center flush with the foundry floor.

Bearings must be made for the boss and the central boxed frame. These are not difficult to prepare as they are in planes parallel to each other. It matters little which of the two bearings is prepared first, the depth being taken from the surface of the pit in both cases. When one is prepared the other may be set from it so that they bear the same relation


Distance Piece
Fig 1 Section Showing Bearings in the Pit
Approximate Set Back of Centers
A Given Dimension
Fig 2
General Method of Preparing Bearings
Fig. 3 Sectional View of Pit with Pattern Sections on Bearings
Fig 4
Plan of Pattern Screwed up and Set on Bearings

FIGS. 1 AND 2—GENERAL METHOD OF PREPARING BEARINGS FOR PIT MOLDING A PROPELLER SHAFT BRACKET FIGS. 3 AND 4—PLAN AND ELEVATION OF THE PATTERN ASSEMBLED AND SET ON BEARINGS

to each other as the bottom of the boss bears to the bottom of the center piece of the pattern. The general formation of these bearings is shown in Figs. 1 and 2. A distance piece shown in Fig. 1 is useful for setting the straight edges at their respective levels.

The positions for two dimensions are shown in Fig. 2. They serve as a guide to the molder in making the beds to suit the pattern. In the formation of each bed the straight edges should be set level and the sand rammed and struck off in the usual way and since a considerable portion of these bearings will form a part of the mold with which molten metal will come into contact, special composite facing should be used. The services of the patternmaker usually are requisitioned for setting the pattern upon these bearings, especially when the pattern is to be assembled upon them. When the beds have been tested and found correct, it is preferable to bed in the print from the boss. For this reason it is advantageous to have this print located on the pattern with dowels. The boss pattern is lowered into position upon the bed and the framed center piece is also set upon its bearing. The projecting rib is removed before this operation, the arm being suspended on a crane while it is screwed into position and the segments of filleting attached. Then the whole pattern may be rotated around the boss print until the center frame occupies a central position on its bearing as shown in Figs. 3 and 4. Some molders prefer to mark the position of any small projecting part and remove the main pattern to have it bedded in but frequently this it unnecessary. In this instance the bed can be cut away and the projecting part bedded in from the side while the pattern is in position. The molder merely must make sure that it is in contact with the bottom of the pattern and beveled in conformity with it.

Runners Determined

Before commencing to ram up the pattern in the pit the method of running the job must be decided in order that the necessary provisions may be made. Frequently castings of this type are poured by a spray to the boss, but since the height is great and metal under heavy pressure would impinge upon the shaft core, it is more practical to supply metal to the bottom of the boss. With such a runner it is customary to prepare a special block or core forming the U-connection between an ordinary straight gate and the bottom of the pattern. This block should be made of a highly refractory special composite, and should be bedded into position forming part of the bearing as indicated by the dotted lines on Fig. 2. With such a large casting it is an advantage to use a supplementary gate with sprays to the center rib of the boxed section as shown in Fig. 3. With these gates set the sand may be rammed about the pattern. It is wise to set weights upon the boss and boxed section of the pattern to prevent an upward thrust when sand is rammed around the lower part of the pattern. A quantity of cinders worked in, and covering an area beneath the arm is valuable, both as a vent and also to establish a plane of weakness in the body of sand which will allow a certain freedom for contraction. Ramming may proceed around the boss and the arm until a support has been given to the pattern, when the cores in the boxed frame may be commenced. In some instances it is preferable to ram the whole of the outside, but as the sides of this pattern are framed together, advantage may be taken of the greater access provided when filling the cores.

The rib through the framed section makes it necessary to provide two distinct cores except for the lightening holes through the vertical sides, each of which require separate cores for convenience. However, the two main cores may be secured together after they are dried and painted. The two cores then may be lowered into the mold with the lightening core inserted. These cores continue from the boxed section to the rib in the arm. For this reason an ordinary flat grid is not suitable. A combined grid is used as it is sometimes better to have the grid which carries the staples as near to the bottom of the core as possible, and the prods in a vertical direction for greater convenience in making up the core. The combined grid used consists of two grids formed in such a way as to be easily secured together to form a shape suitable for either of the cores. Such a grid is shown in Fig. 8. This

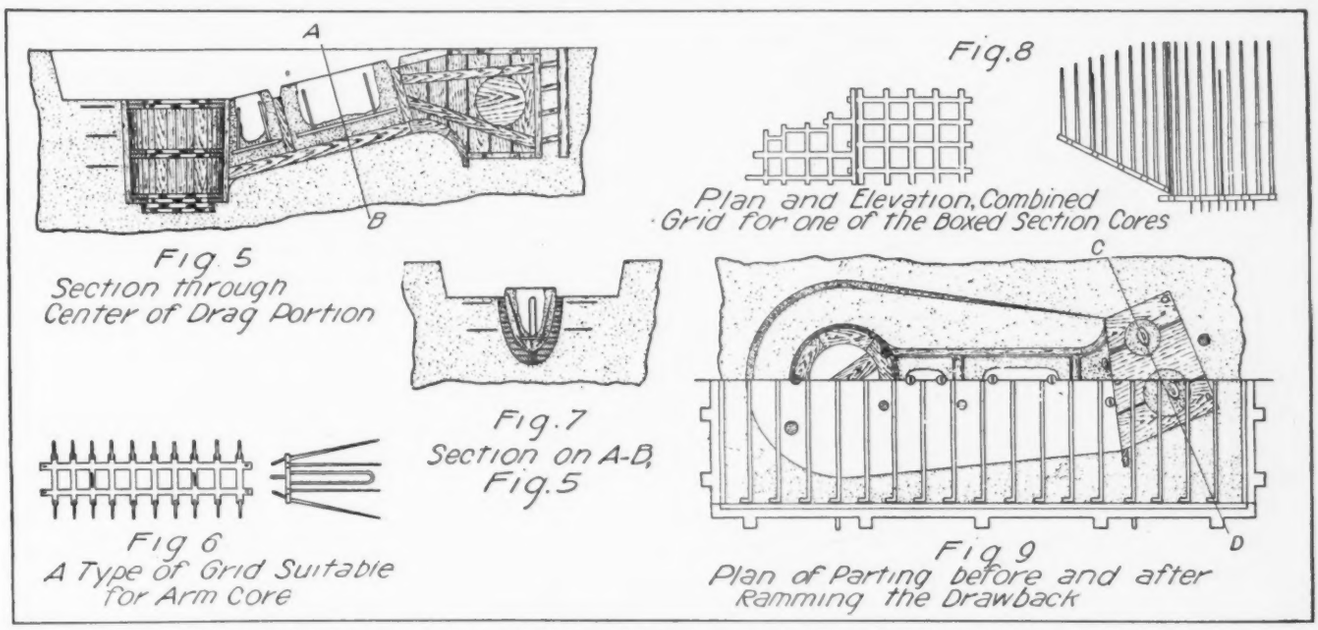


FIG. 5—SECTION THROUGH THE CENTER OF THE DRAG PORTION OF THE MOLD FIG. 6—TYPE OF GRID USED FOR THE ARM CORES FIG. 7—SECTION ON *AB*, FIG, 5 FIG. 8—COMBINED GRID FOR THE BOX SECTION CORE FIG. 9—PLAN OF PARTING BEFORE AND AFTER RAMMING THE DRAWBACK

is a convenient form for the largest of the two cores. When making this grid it is best to strike out an approximate circle representing the lightening hole at the bottom. This will act as a guide in setting a few pieces of wrought iron. Then, after the grid is cast, a length of nail rod can be wired to it to give strength to the projecting portion of the core.

A bedding of composite is made, the grids set into position and both cores may be built, the top plate of the pattern having been removed. When the cores are made up to the under side of the plate they should be sleeked over to allow the part of the pattern to be replaced. The cores then may be continued to the surface. Between the rib of the arm, and the edge of the top plate, prints may be formed to project from each core as shown in Fig. 5. It is necessary to remove the screws which may be holding loose parts while the cores are being formed. When the cores are finished the framed sides of the pattern will require attention. The composite should be struck off to the depth of the plate between the frames, the spaces filled in with ordinary floor sand, sleeked smooth on the outside and the outside ramming is continued.

Pieces of iron are rammed in at intervals, at right angles to the vertical sides as shown at Figs. 5 and 7. These give additional strength to the mold.

The joint should follow the surface of the pattern and be carried back a reasonable distance before being connected with the floor level by a taper as shown in Fig. 5. The plan of a good parting is shown in Fig. 9.

With the joint formed the arm cores may be commenced. Two grids, a common type of grid for which is shown in Fig. 6 are required. The cores do not take much time, a body of composite about 3 to 4 inches thick being sufficient, with the center well filled with cinders. The general formation of these cores is shown in Fig. 5, and the section on *AB*, Fig. 7. It will be noticed that they are continued beyond the pattern to form prints having considerable taper. These are the only means for locating the position of the cores when closing the mold.

When the depth of lift from the surface of the boss to the floor level is not great, the whole may be carried with the cope box, providing special provision is made for carrying it, either by the use of gaggers or better still by grids firmly secured to the top bars. However, with such a deep lift as is necessary in this bracket, it is preferable to make a separate lift in the form of a drawback so that its surface will coincide with the upper joint of the mold on the floor level. There is an added advantage in the use of such a drawback, since it allows the arm cores to be firmly secured to it, instead of having them bolted through the top flask. When making such a drawback some molders prefer a built-up grid consisting of two pieces bound together with shaped bars, but while there is much to be said in favor of such a form, the type of grid shown in Fig. 13 will usually fulfill similar conditions, and require less time in preparation. However, a large number of prods should be cast with this form of grid. Whichever form grid is used, care should be exercised in making suitable allowance for the main gate and risers, and also for bolts, which are required to fix the arm cores to the drawback. The general shape of the drawback is illustrated in Fig. 9, one part of which shows the joint of the mold and its relation to the pattern, and the other, the drawback rammed. It is advisable to set pieces of piping over the staples in the arm cores, so that they are easily accessible. Gates and risers need to be in position, and the cope partially rammed.

When every convenience is available for cutting off headers from the casting, risers need not be spared. Oxyacetylene appliances or the electric arc considerably reduce the amount and cost of labor in removing

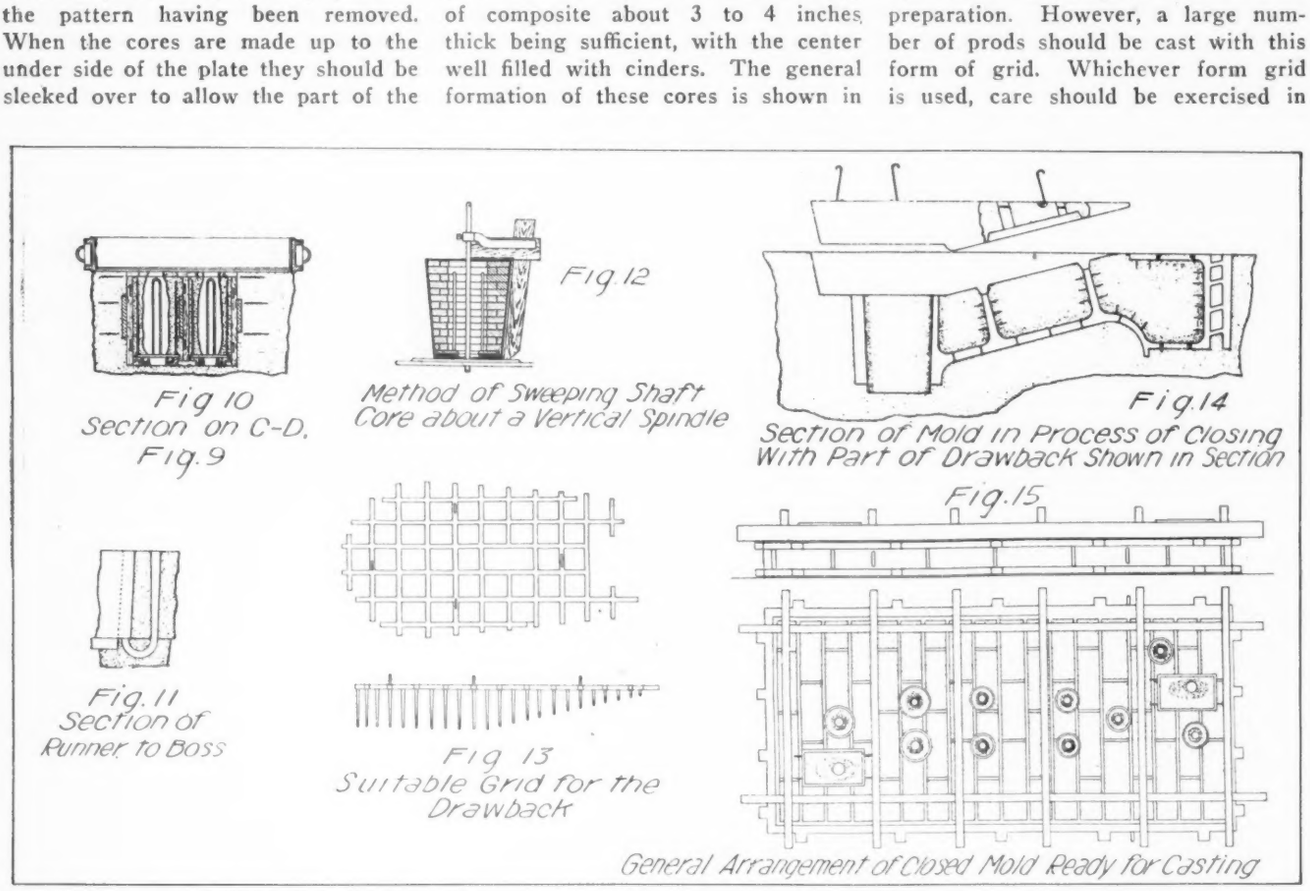


FIG. 10—SECTION ON *CD*, FIG. 9 FIG. 11—SECTION OF THE RUNNER TO THE BOX PORTION OF THE CASTING FIG. 12—METHOD OF SWEEPING THE THE COMPOSITE SURFACE OF THE SHAFT CORE FIG. 13—PLAN AND SECTION OF THE GRID FOR THE DRAWBACK FIG. 14—SECTION OF THE MOLD IN THE PROCESS OF CLOSING, SHOWING A SECTION OF THE DRAWBACK FIG. 15—MOLD ASSEMBLED AND READY FOR CASTING

headers from the large steel castings.

The cope for such a job is the simplest, forming practically a flat top, only a small portion of which comes in contact with the pattern. A built up flask part, such as is shown in Figs. 9 and 10 is suitable for such a cope, or since the bars are all straight, a solid box will do equally as well. A section through *CD* in Fig. 9 is shown in Fig. 10, with the cover flask in position and showing the general formation of the center piece cores. When the cope has been rammed, stakes driven in to locate the position of the cope, gates and riser sticks withdrawn the cover flask may be lifted. A suitable bed or support is made for the drawback which is the next lifted and then a start may be made on the pattern.

Drawing the Pattern

It is necessary to exercise care to obtain a clean draw. This requires the removal of the pattern sections in proper order. The first piece to be lifted is the boss, which, owing to the taper, gives little trouble. Then the arm cores may be removed, the one nearest the boss being lifted first to release the rib, and allow the next core to be removed. The top plate of the boxed section should be lifted and the three sides well rapped. If the pattern has been given the proper taper the cores will lift satisfactorily together with the central rib and the bottom plate. The side plates are then easily removed. With the exception of small subsidiary portions, there remains the arm section to be lifted.

Usually the loose cores and drawbacks are placed in an oven and some form of drier used for the main part of the mold with the cope supported over it. The principal core remaining to be made, that is, the shaft core is often made about a spindle on racks in a horizontal position. As has been explained in a previous article, the advantage of such a method is more in evidence when it can be set in a horizontal position in the mold. However, it is better to make such a core on end if it is to be lowered into the mold vertically, especially if the diameter is such as to allow this being done conveniently. For this purpose a sweeping board is made, such as is illustrated in Fig. 12, and fixed against a spindle by being bolted or clamped to a spider or tail-piece secured to the spindle. The sweeping

With the cross piece of the sweeping board cut to suit the spindle and the bottom set to the diameter of the print, by means of a gage stick the core can be built up. A ring plate with suitable lifting staples is bedded into composite, and the core bricked up, until the composite swept on the outside forms the surface as shown in the sketch. Slab cores are needed for the lightening holes. All of these should be dried. Pouring basins and headers also are prepared and placed in the oven so that all will be in readiness for the final process of painting, an operation which is performed over all that part of the mold and cores, with which the molten metal comes in contact.

Considerable care is required in closing such a job. The lightening cores should be secured in their relative positions, the outside cores being rubbed clear to allow the two cores forming the boxed section to be lowered into the mold without crushing. Chaplets are placed under the overhanging parts to hold them in position. When these are set hoop iron wedges should be fixed between the lightening and main cores to prevent any movement. The shaft core is next lowered into position flush with the parting and tested for uniformity of thickness about the surface. When possible the arm cores should be secured to the drawback before being lowered, and then only an occasional chaplet need be nailed to the bottom of the mold. Sometimes this method is not convenient and the cores have to be set with nails or chaplets along the sides and the drawback lowered afterwards. If considerable taper is given to the prints, this may be managed satisfactorily, but great care is necessary in setting the cores as measurement must be accurate to assure the proper metal section. Once the drawback is set these cores may be bolted through to the grid enclosed in it. The overhanging ends of the center piece cores also may be bolted in place. This leaves the face which is to be machined free from chaplets. The general appearance of the mold is shown by the section in Fig. 14.

When the mold finally is closed all runners and risers clear and the cope lowered in position, the runner and riser heads are grouted in their relative places and the whole weighted down for casting. When the work is molded in a flask bedded in the floor the cope flask may be bolted or clamped to the top flange of the drag. Bars of cast-iron are laid over the top clear of the headers as shown in Fig. 15 and block weights are set on these to prevent any possible lift of the top when casting. The metal is supplied by way of the boss first, and a considerable quantity of metal poured before the other gate is used. After the job has been cast and the metal becomes set, the cover may be lifted and the drawback eased. This assists in freeing the casting for contraction. When it is safe to lift it is moved to an oven where it is packed

Bill Risks His Life to Inspect a Sand Mine

(*Concluded from page* 831)

ready for shipment and finally we saw the dryer where the sand is dried in an immense kiln for sand blasting purposes.

"We were told that the deposit consists of a huge mass of conglomerate silica quartz made in the days when the earth was young and pressed into a solid block by one of those glaciers which geological science assures us were in the habit of moving around from place to place in those days. Would you believe that stuff analyzes over 98 per cent silica? It is prepared for use as steel molding sand and different grades of sandblast sand ranging from the coarse heavy stuff that would cut a hole through a steel plate down to the light delicate stuff which might be used in the mint for shining the tail feathers on the Bird of Liberty. After figures pass a certain point they do not convey a very clear impression so it is no use telling you that the plant has a capacity of over 1000 tons a day and that over 100,000 tons are always kept in stock. There are two piles of sand down there, which if spread out would cover just about as much territory as the famous Sahara desert, while the pile of gravel which may be regarded as a by-product in the preparation of sand is, as nearly as I can judge from memory, about the same size and shape as Mount Ararat.

"I generously resigned my seat in the big car in favor of a man who was heavily insured and rode back to town with a citizen who had a shining dome, a warm heart and likewise a set of good steady habits. He liked to travel in the middle of the road and have her hitting on all four wheels all the time."

Bill took his long feet off the chair and stood up. "Well," said he, "I guess I'll be on my way. I am glad I came over, I certainly enjoyed your conversation." When he had gone, my sparring partner who is a perfect lady surprised me by saying:

"It is a pity some one did not push him into that big thing he saw crushing the rocks." I mildly inquired the reason for such a ferocious desire and what do you think she said?

"No one has a chance to say a word when he is around."

Effects of the Contraction of Iron

Castings Are Frequently Cracked Due to Contraction—Cores Which Do Not Break Up as Casting Sets and Faulty Design Are Among the Causes of This Trouble

BY ERNEST SCHWARTZ

FEW of the phenomena of foundry practice seem to be so little understood as that of the contraction of iron when cooling. Is there any difference between the contraction of thin and heavy castings and castings made of hard or soft iron, and is this contraction gradual or rapid, are a few of the points to be considered in a discussion of this subject. It has frequently been stated that castings have little or no contraction vertically, but this is not borne out by practical tests which I have made, nor by my experience in foundry practice.

Some time ago I had two patterns made, each 54 inches long and 1 inch square, which were molded separately in different flasks. One flask was suspended to permit of casting the mold vertically, while the other was cast horizontally. When molding the one that was to be cast vertically, care was exercised to ram it to obviate straining on the sides and to prevent the lower end from straining. An iron shell was placed firmly against the end of the pattern. Both molds were poured from the same small ladle of iron and when the castings were shaken-out, it was impossible to identify the casting poured vertically, as both were of the same length, indicating that the contraction of the casting poured vertically and the one poured horizontally was the same.

Some foundrymen may claim that they have measured many castings that have been cast vertically and have been able to detect no contraction. This may be true and furthermore, many castings made in this way frequently measure longer than the original patterns. Also, many castings poured horizontally have been found to be longer than the original pattern. The cause of the latter may be assigned to the straining of molds. The molder or patternmaker who has had experience in making heavy rolls, as a rule will make the lower end of the swept mold or pattern smaller than the opposite end. The reduction in size will depend upon the length and body of the casting and will vary under different conditions from $\frac{1}{8}$ to $\frac{1}{4}$ inch. It is not an unusual occurrence for the superintendent of a rolling mill to complain to the foundry foreman about the variations in the sizes of the rolls furnished for the rolling mill. This difference in size is particularly noticeable between the extreme ends of a roll. In the manufacture of rolls the vertical contraction of iron has frequently been proven. It is not unusual for the upper wabblers to crack and pull off the neck of the rolls, due to no other cause than that of contraction and the carelessness of the molder. When feeding a roll with hot iron to compensate for shrinkage, molders occasionally will form a flange on top of the feeding basin which will extend out over the iron flask or box that is used for forming the feeding head. When the cooling crust of iron begins to contract, it is supported by the flange and as the iron cools, a crack will form in the neck or on the wabblers because the metal in the feeding basin cannot lift the entire roll from the bottom of the mold.

Cores May Hinder Contraction

In many cases it is impossible to avoid the straining of the bottom portion of a mold that is cast vertically. Both loam and dry sand molds are strained to some extent, but not nearly so much as green sand molds. To ascertain whether a casting has contracted vertically, it is necessary to make exact measurements of the molds and to note the size of the pattern or sweep, since there is frequently a difference between the size of the mold and the sweep or the pattern.

After the casting has been shaken-out of the sand, compare it with the measuring rod and carefully note and allow for evident results of straining. I believe that it will be found that the casting will have contracted vertically as much as it would have contracted horizontally, were it possible to have cast it in the latter position. Frequently, castings are poured horizontally which not only do not contract, but are larger than the patterns from which they are molded, and particularly is this true in heavy castings.

Cores sometimes have a tendency to prevent the free contraction of castings. Occasionally castings of light sections, with cores almost entirely surrounded with metal, will crack because the body of iron is insufficient to cause the crushing of the core when the iron cools. When iron is run all around cores and when its thickness is in excess of 1 inch, the cores frequently will expand to such an extent that they will force the iron through the feeding heads, risers and pouring gates. If the gates are frozen immediately after the mold is poured and thereby prevent the egress of the expanded iron through the gates, the iron will press against the sides and surfaces of the mold, forcing them outward and when the casting is shaken-out, it will be found to be larger or as large as the pattern from which it was made, thereby indicating evidently that no contraction has occurred.

The softer the iron, the lower will be its ratio of contraction. Heavy bodies of iron contract less than lighter sections and the greater the percentage of contraction in iron, the more liability is there for castings to crack. Castings having both light and heavy parts combined or connected, always are strained. Patternmakers usually provide for the same shrinkage on all iron castings. If patternmakers would make a small piece the same size as some part of the mold to be poured and have this piece molded and cast from the same iron and at the same time that the casting is to be poured, they will find that generally the iron contracts differently in the small piece than in the casting itself. When a casting is found to be too large, the patternmaker is blamed immediately until investigation proves the contrary to be the case. However, after the pattern is measured and is found to come up to dimensions, the conclusion is reached that the molder is to blame. Much valuable information would be gained by foundrymen if they would take accurate measurements over a period of one or two months of all of the different castings produced in their shops. During this period test bars of all of the different grades of iron that are used in the foundry should be made and after noting their

contraction, their tensile strength should be ascertained. From this accumulated data much valuable information could be secured relative to the contraction of castings. The molder or patternmaker is not always responsible for the cracking of castings. Engineers and draftsmen often design forms that the best of iron and foundry practice can not possibly prevent from cracking. Occasionally, castings will be in a shop for weeks and even months, when they suddenly will crack.

Recently I cast a bar 4 x 9 inches and 14 inches long, and with the same ladle of iron I poured a test bar of the same length and ½ x 2 inches in cross-section. Both of these bars are shown at *V* and *D* in the accompanying illustration. The contraction of the 4 x 9-inch bar was only ⅞-inch while that of the ½ x 2-inch bar was 1¾ inches, or a difference of ⅞-inch. This is evidence of the strain always present in castings improperly proportioned and also indicates the difference in the contraction of light and heavy bodies of iron.

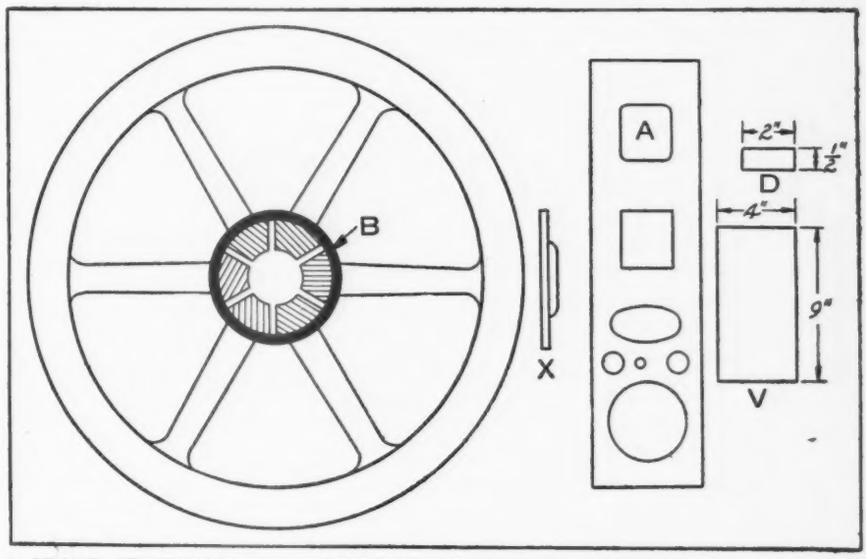
Interesting Contraction Tests Made

To test the difference in the strength of castings poured with hot iron and with dull iron, I made two bars and poured one with hot iron while the other was poured with iron as dull as it could be made and still run with safety. After the bars were shaken-out of the sand and had cooled they were tested to ascertain their breaking strength. The bar poured with hot iron was tested first. It was supported a distance of ¾-inch on either end by solid iron bearings and 50-pound scale weights were loaded onto the center until the bar was broken. Eight of these weights were sustained by the bar, but when the ninth weight was added, the bar broke. In other words, the bar was able to sustain a weight somewhere between 400 and 450 pounds. On the other hand, the bar poured with dull iron sustained a weight of 510 pounds. These bars were 4 feet 6 inches long and 1 inch square.

Frequently, iron plates are cast with holes arranged symmetrically to reduce their weight and when introduced for this purpose these holes should be round, oblong or oval, instead of square. However, if the corners of square openings are rounded, the cracking of the plate can be obviated. A heavy rib cast onto a plate to strengthen square openings sometimes will do more harm than good, as it sets up strains by making the casting of disproportionate size. A square opening with rounded corners is shown at *A* in the accompanying sketch and *X* illustrates a heavy rib cast onto a plate. Castings provided with heavy projections, flanges or ribs, frequently crack and probably would have been much stronger if these parts would have been eliminated. Cracks generally start from some thin or sharp corner and when once started, extend through the entire body of the casting, the thick portions offering no more resistance apparently than the thinner sections. When molding a new pattern, a molder should pay particular attention to sharp corners that will be subject to strain or disproportionate contraction and should recommend that the sharp corners be rounded and the thin sections be made heavier, or the heavy sections lighter, and vice versa.

Frequently, the cracking of castings can be obviated by exposing heavy portions to the air immediately after casting. In the accompanying illustration is shown a flywheel with the hub split between every arm. A wheel made in this way seldom will crack as each arm practically is a separate casting and is free from strain or pull otherwise set up when attached directly to the hub. The spokes of wheels made in this way are banded with wrought iron rings and the openings in the hub are filled with babbitt metal. Wheels cast with iron arms, rim and hub all in one piece, generally are strained, the extent of the straining depending on the relative proportions of the rim and arms. If the rim is light and the arms heavy, a cracked rim may be looked for, which is caused by the thin rim contracting and cooling more rapidly than the arms. On the other hand, if the arms are lighter than the rim, then the arms will crack. As a rule, this cracking occurs while the castings are still in the sand and many foundrymen attempt to obviate this through the exposure of the rim to the air, if heavy, to expedite cooling. On the other hand, if the spokes are heavier than the rim, then these are promptly uncovered to facilitate cooling.

However, the problem of casting pulleys is more complicated. The arms, as a rule, are heavier than the rim, yet the arms frequently will crack and the light rim will remain intact. However, the hubs of such castings are heavy in proportion to the arms and the rim. The hub is the last part of the pulley to become solid. The rim, on the other hand, being light, has cooled before either the arms or the hub, and while contracting is driving before it the half molten arms into the yet liquid iron in the heavy hub. When the latter solidifies, the contraction pulls the arms with it, thereby setting up strains and when the pulley is jarred slightly, it will cause the arms to crack at their weakest point. Where pulleys are provided with heavy hubs, these should be uncovered immediately after the mold is poured, the core removed, and cooling with water frequently is resorted to.



A METHOD OF AVOIDING THE CRACKING OF FLYWHEELS IS ILLUSTRATED AT *B-D* AND *V* ARE SECTIONS OF TEST BARS USED TO DETERMINE CONTRACTION

Unequal Cooling Causes Trouble

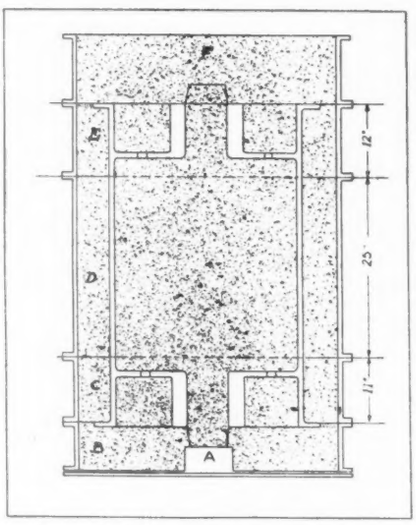
When castings cool, some of their parts always cool more rapidly than others, and those cooling first are on the exterior or exposed sections. Castings frequently are cooled solid on the outside while the inside is still in a molten state. In discussing this problem we will refer to the castings shown in the accompanying illustration, each 14 feet long, the one 4 x 9 inches in section, and the other

½ x2 inches. These were cast with the same iron and at the same time. The light bar, owing to its smaller section, cooled more rapidly than the heavy bar and the action of contraction was more rapid than in the heavier casting. The outside portion of the heavy casting cooled and contracted first, but inside contraction was retarded. An examination of this casting would show that inside of the cooled exterior of the casting, the iron is still very hot and the temperature increases as the center of the casting is approached. Therefore, while the outer portion of the casting may be in a state of contraction, the inner portion of this casting has not yet attained the contraction stage, and this inequality frequently is the cause of the cracking of castings.

Referring to the cooling casting we find that the slower interior cooling iron will not permit the more rapidly exterior cooling iron to contract as much as it should, and by this cooling process we have the exterior portion of the casting contracted by forces which retard it from contracting as much as it should otherwise. When the interior portion contracts, it encounters the same resistance to its natural contraction, the exterior having lost most of its heat and, therefore, having contracted all it can, it will not permit the interior to contract any more than the exterior portion. Therefore, we find that the small test bar which does not have to contend with these conflicting forces of nature, and which is permitted to contract more naturally than the 4 x 9-inch bar, will more easily attain the limits of its contraction than the larger bar whose contraction will be about one-half of what it should have been had the metal been as free to contract as that in the lighter bar.

When changing from a liquid to a solid state, iron is said to become a mass of crystals which assume various forms and sizes, being regulated by the length of time the casting requires to cool and the temperature of the iron when poured into the mold. The lines of crystallization are seldom visible to the eye, except in the case of chilled iron. The lines of crystallization in castings that are not chilled, depend upon the direction in which the heat passes off most rapidly and with the least resistance. With reference to this formation of crystals, it is an established law of the molecular aggregation of crystalline solids that when their particles consolidate under the influence of heat in motion, their crystals arrange and group themselves with their principal axes in lines perpendicular to the cooling or heating surfaces of the solid.

Sharp angles, corners, projections and squares combined in castings cause them to develop lines of crystallization extending in different directions from some given point. This point from which the lines of crystals radiate, is the weak spot of the casting and there are few castings so shaped, but that many such weak points appear in them. Even if a molder had thoroughly mastered the theory of the crystallization of castings of diffrent form, he could seldom in practice, cool a casting so as to cause the crystals to radiate in such lines whereby the weak points would be strengthened, nor could he change these lines from their natural course. The contraction and cracking of castings involve many interesting and preplexing features and furnish a subject for much interesting study and speculation on the part of the foundryman.



FULL LENGTH SECTION OF COMPLETE MOLD. TO MAKE A SHORT CASTING—OMIT CENTER CHEEK WHEN ASSEMBLING THE MOLD

More About Short Drums From Long Patterns

By Robert Tovell

A short article appeared in the Nov. 1 issue of THE FOUNDRY describing how to make a short drum casting from a long pattern. The method had several commendable features, but where round iron flasks are available I think the following method will be found more convenient. The illustration shows a completed mold made off a full length pattern. If we wish to make it shorter it only becomes necessary to dispense with the center cheek *D* before assembling the mold for pouring. The core, of course in that event would be stopped off in the core box at the dotted line in the illustration.

Taking the job in detail and assuming that it is desired to produce a 23-inch casting from a pattern which is 48 inches long the procedure would be as follows: Select a cheek or a number of cheeks which together will make up the length of the piece to be cut out, in this case it would be 25 inches. Then get two other rings whose combined height would equal the length of the required casting, in this case 23 inches. One 11-inch ring *C* and one 12-inch ring *E* will answer nicely. The depth of the drag and cope *B* and *F* do not matter within reasonable limits. Having selected all the flasks put down the bottom plate and drag approximately level. By measuring the core print on the pattern and also the depth of the drag locate a solid block *A* on the botton plate to act as a bearing for the core. The block may be adjusted with wedges so that when the pattern rests on it the top side of the lower or loose flange will be flush with the joint of the drag. With the core print resting on the bearing the lower edge of the pattern is blocked up in three places and adjusted with wedges until the pattern is perfectly level. A bed of cinders or coke is then laid on the bottom plate and the drag rammed.

The pattern is then taken off and a double row of rods driven perpendicularly to support the mound of sand between the hub and the rim. This body of sand is felt all over and made firm, the wedges used to support the pattern are removed and the cavities filled. It is then vented generously after which a layer of facing sand is spread over the face. The pattern is returned and rapped down into place. The sand around the flange is rammed firmly and a parting made as shown in the illustration. The cheek *C* is then put on, rammed and a good parting is made. This parting must be accurately made because the lower face of the cheek *E* is to coincide with it when assembling the mold.

The cheek *D* is placed on next and filled to the top with sand. The top course is the only one which needs to be rammed because after the cheek has served its purpose it is to be shaken out. It is necessary to make a good parting on the top side. The cheek *E* is then set on and afterward the cope *F*.

The cope is taken off and the pattern drawn. The cheek *E* is lifted off and set down. The cheek *D* is taken off and the sand knocked out of it. The cheek *C* is lifted next and the loose ring pattern removed.

After the mold has been finished and

blacked, the cheek *C* is lowered on first then the cheek *E*. The core is then lowered in and the cope set. When the flask is clamped and the runner made up it is ready to cast.

If I had many of these odd length castings to make I would fit up a cast iron ring which would embrace the pattern loosely and have it mounted on telescopic legs. By adjusting the ring to various heights I could ram any depth of cheek necessary and do away with all the false work.

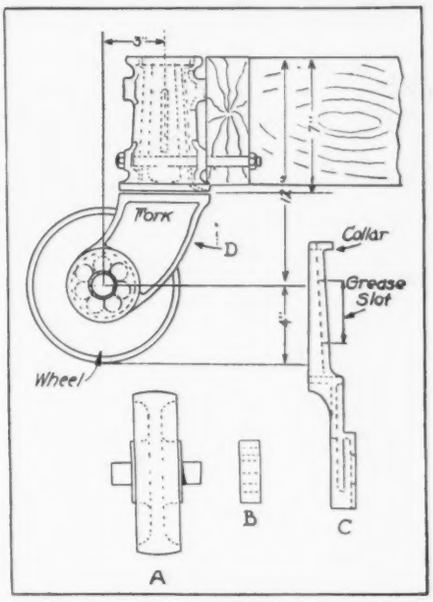
Efficient Truck Casters

By M. E. Duggan

In a shop or factory where industrial trucks are used to any extent the design of the wheels and casters is an important consideration. Too often the first cost is the only item figured and no thought is taken of future repair bills due to faulty or careless construction. Neither is there any cognizance taken of the extra labor required to move a truck mounted on wheels which do not move easily. In fact the statement sometimes made that a truck moves just as readily with or without wheels is only slightly exaggerated.

A shop truck caster which can be made in the foundry without any machine work is shown in the accompanying illustration. The essential parts are shown at *A*, *B* and *C* and the assembled caster at *D*. It is light and strong with no small parts to work loose and lose.

Taking the different pieces in the order in which they are shown, *A* is a cast iron one-piece wheel and axle; *B* shows the hard iron rollers; *C* is a cast steel fork or shank provided with a recess on each side for the rollers. The fork is cast in two halves and welded after the wheels and rollers have been assembled. The box in which the caster revolves is also cast in two halves. It is assembled and fastened to the truck by four bolts, one of which is shown in the illustration.



A LIGHT, STRONG, EFFICIENT AND EASILY MADE TRUCK CASTER

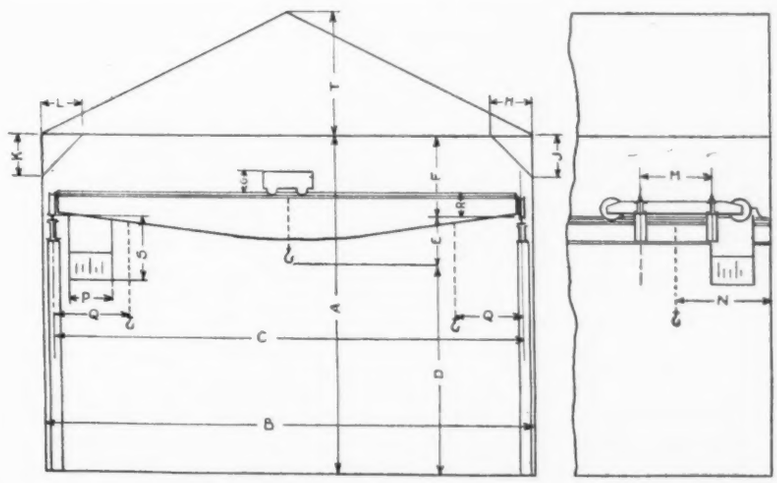
Crane Information For the Office File

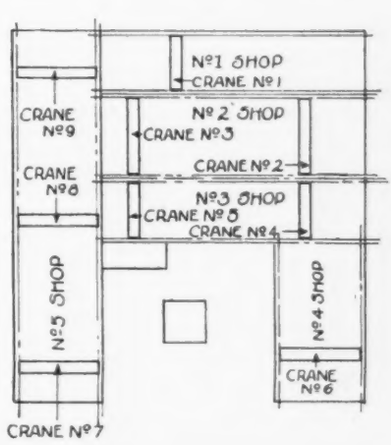
By George W. Childs

In the accompanying illustration is shown a diagram and list designed to furnish the foundry office with easily accessible information regarding the crane installation in the plant. On the right of the sheet appears a diagram showing the location and serial numbers of the overhead traveling cranes in the different shops. On the left are diagrams of a building lettered for building and crane clearances. Below the diagrams will be found a table in which all the cranes are enumerated giving the following details: Serial numbers to correspond with the serial numbers of the cranes in the diagram of the plant, the maker's name and the serial number, shop location, clearance dimensions of cranes and buildings, general capacity, etc.

I have prepared similar drawings for our works and they have been exceedingly useful. Considerable time and labor are saved at various times by having such information on hand. It is not necessary to go out into the works to get dimensions of the cranes and buildings every time such information is needed. Neither is it necessary to look through the files of crane drawings at times to find the makers' name or other particulars. In the writer's opinion steel works and industrial plants in general would be greatly benefited by having prepared and filed drawings similar to the one illustrated.

The Hills, McCanna Co., 153 West Kinzie street, Chicago, manufacturer of brass and aluminum castings, has recently acquired a plant at 2025 Elston avenue, Chicago. This plant affords ample space for the expansion of the company's machine shop and foundry.





Nº	MAKER	MAKER'S Nº	LOCATION	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	CAP. HOIST MAIN	CAP. HOIST AUX.	WEIGHT OF BRIDGE RAIL	WEIGHT OF RUNWAY RAIL	SPEED IN FEET PER MINUTE - FULL LOAD BRIDGE	MAIN HOIST	AUX. HOIST	TROLLEY
1	MORGAN	0176	Nº1 SHOP	25-0"	50-0"	48-0"	20-0"	19½"	3-4½"	2-11"	24"	24"	20"	20"	7-0"	8-3"	5-6"	5-3"	30"	7-0"	8-0"	25	10	55 LB	70 LB	225	18	34	210
2	ALLIANCE	6-8-10	" 2 "	30-0"	60-0"	58-0"	25-3"	12"	3-7"	3-4½"	24"	24"	24"	24"	5-0"	6-0"	5-3"	4-3"	24"	6-6"	10-3"	15	-	55 "	65 "	275	23	-	260
3	CLEVELAND	58-A	" 2 "	30-0"	60-0"	58-0"	24-2"	25"	3-9"	3-0"	24"	24"	24"	24"	5-6"	6-0"	5-0"	4-1"	24"	4-0"	10-3"	15	-	55 "	65 "	310	29	-	289
4	ETC																												

BUILDING AND CRANE CLEARANCES AND CAPACITIES FOR OFFICE RECORD

THE FOUNDRY

A semimonthly journal devoted to all branches of the foundry trade

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Contents

	Page
Strive for Strength in Malleable	803
Difficulties Experienced in Machining Malleable	807
New Foreign Offices Are Established	809
Pipe Molds Made From Rotating Patterns	810
Loam Mold for Evaporator Steam Belt	811
Equipment and Methods of Tinning	817
How Treatment Affects Bearing Metal	820
Offers Training Course in Torch Welding	820
Radiator Foundry to Use Iron Molds	821
Female Workers in British Foundries	822
Steel Castings in Brazil	823
Scale on Malleable	823
Better Steel Castings Are Required	824
Study Common Aluminum Alloys	827
How and Why in Brass Founding	828
Copper Castings for Use as Electric Terminals	828
Overcoming Pinholes in Aluminum Castings	828
Facts About Antimonial Lead for Die Casting	828
Brittleness in Lead-Copper Packing Alloys	828
Melting Antimony and Bismuth	829
Plastic Material Sought for Molds	829
High Zinc in Aluminum Causes Unsoundness	829
Standard Trolley Wheel Mixtures	829
Bill Risks His Life to Inspect a Sand Mine	830
Castings for Ship Construction—XIV	832
Effects of the Contraction of Iron	836
More About Short Drums From Long Patterns	838
Efficient Truck Casters	839
Crane Information for the Office File	839
Two Training Plans	840
Trade Outlook in the Foundry Industry	841
Comings and Goings of Foundrymen	842
What the Foundries Are Doing	843
New Trade Publications	844

Two Training Plans

WIDELY divergent as the poles and rapidly drawing apart from each other are two schools of instruction, each of which has for its object the training of foundry workmen. The one, largely represented in the ever-growing group of repetition shops, seeks to educate beginners and apprentices along specialty lines. Each individual is taught one task, and kept steadily at his work until the different steps of the entire operation become mechanical and are performed in a minimum of time. The sequence of work becomes clock-like in its precision, and a maximum production per man is attained. Each individual is a specialist. This system develops workmen who are expert in certain detailed operations, but who have absolutely no conception of the interrelation or sequence of production. Their usefulness is limited and their vision undeveloped.

The other school at first follows the same line as that just described. The beginner is taught one operation or series of operations. He may be assigned to a molding machine, handling a cope, and kept at this work until he attains maximum proficiency. Then he is transferred and given another task. He may be assigned another machine, placed in the coreroom, the patternshop, or on the charging floor, but in any event, as soon as he becomes especially proficient in each succeeding job he is moved to another until he has completed the entire cycle of operations in the plant. The experienced manager may at once dismiss this plan of training as inefficient. Admitted beyond question is the statement that some time is lost and some work is spoiled by inexperienced workmen. Further, at all times and throughout the shop, there is a maximum number of workmen who must be classed as beginners. However, those who have tried this training procedure report an ultimate gain.

In one large plant where repetition work predominates the rotative plan of training has been in force for nearly two years. It is applied to all who enter the employ of the company and who express an inclination to familiarize themselves with the business. Those who persist under the plan are found to retain a large measure of the proficiency which they gain in each task. Further, those in training express a greater interest in their work, and escape that condition termed in athletics "going stale," which sometimes results where a high type workman is given one task and kept at it until his work becomes monotonous. It is true that under the rotative plan some employes become discouraged, particularly those who are restive at being compelled repeatedly to start at the bottom. These in many cases drop out and do not finish the entire cycle of operations in the plant. However, their percentage is small and the management regards this condition as favorable, stating that those who drop out would eventually prove to be erratic and discontented employes. Those who finish the entire course of training in all the different operations about the plant have a general knowledge of the business, an insight into the co-ordination of the different departments, and a real incentive to advancement.

Trade Outlook in the Foundry Industry

WITH unprecedented opportunities for desirable business, foundry men during the past few months have been confronted by a succession of hampering circumstances tending to produce a rise in price in all the component materials entering into castings manufacture. The most recent and most serious problem has been injected by the strike of bituminous coal miners. This menace to foundry industry is two-edged. A coke shortage may so restrict the output of pig iron that a famine condition may ensue. Foundry coke shortage, also, if the strike is allowed to continue will retard the production of castings. At present the great coke producing region, known as the Connellsville district, remains free from labor trouble as the miners are not organized and the coke ovens are in full operation. In the South, also, both furnace and foundry coke are being produced in quantities, operation not having been affected by the strike. The only possibility remaining, therefore, is a continued shortage of coal for railway and more urgent uses, which might result in confiscation of coal now mined for coking purposes. There is, of course, a remote possibility that continued restriction of shipping which will limit railway transportation to absolute necessities might result in an embargo on shipments of iron. However, practically all the available supplies of foundry iron for November shipment have been taken and much of that for December is going fast. High silicon, or silvery iron is practically unobtainable. Here the coal strike has a direct effect, as a proportion of coal is used with the coke in the blast furnaces making these grades. One furnace in southern Ohio which was down for relining and which was to have been blown in during the first week of November still is unlighted as only a few weeks' supply of coal was in the company's yard.

Prices of Raw Materials for Foundry Use

CORRECTED TO NOV. 7

Iron		Scrap	
No. 2 Foundry, Valley	$31.00	Heavy melting steel, Valley	$20.00 to 20.50
No. 2 foundry, Birmingham	29.50 to 30.00	Heavy melting steel, Pittsburgh	20.50 to 21.00
No. 2 Foundry, Chicago	30.00	Heavy melting steel, Chicago	20.50 to 21.00
No. 2 Foundry, Philadelphia	34.10 to 34.60	Stove plate, Chicago	25.75 to 26.25
Basic, Valley	25.75	No. 1 cast, Chicago	29.50 to 30.00
Malleable, Chicago	30.50	No. 1 cast, Philadelphia	26.00 to 27.00
Malleable, Buffalo	32.00 to 33.00	No. 1 cast, Birmingham	24.00 to 25.00
Coke		Car wheels, iron, Pittsburgh	24.00 to 25.00
Connellsville foundry coke	6.50 to 7.00	Car wheels, iron, Chicago	28.00 to 28.50
Wise county foundry coke	8.00 to 8.50	Railroad malleable, Chicago	24.00 to 24.50
		Agricultural malleable, Chicago	24.00 to 24.50

Prices Go Higher

With the threatened shortage acting as a lever, prices on coke, pig iron, and scrap are advancing. The reserve stocks of iron in furnace yards have been steadily depleted from week to week during the past few months. Owing to increased production and scant shipments from furnaces, foundrymen who had accumulated a reserve have been forced to make some inroads into their surplus stock. As a result the demand for iron has strengthened. As may be noted from the table of prices accompanying, all grades have advanced during the past two weeks, and markedly since Oct. 15. Southern furnaces now are asking the following prices for the small amount of iron they will have for the remainder of the year: Silicon 1.75 to 2.25, $30; 2.25 to 2.75, $31.20; 2.75 to 3.75, $32.40. The same scale of prices is quoted for first half, 1920 delivery. Eastern foundrymen are exhausting every possible resource to obtain additional iron. Prices have been secondary and the silicon limits have been disregarded by foundrymen where odd lots have become available. Southern furnaces have withdrawn entirely from the eastern markets, and Buffalo and northern Ohio furnaces form a doubtful source of supply in view of the competing demand in surrounding territory and the willingness of local consumers in many cases to pay premiums for immediate supplies. Although the present iron market is regarded as artificial by reason of the coal strike, the general opinion holds that a higher level will govern due to advancing costs. Iron producers have reluctantly quoted on 1920 delivery because of this uncertainty, and some high cost furnaces threaten to close down to await better conditions. Scrap prices have kept pace with pig iron, particularly the cast grades. The restriction placed on pig iron production by the steel strike was almost eliminated during the past month. On the last day of October there were 54 more blast furnaces in operation than at the close of September. During October, 16 merchant stacks were blown in and only three banked, making a net gain of 13 furnaces in operation. Merchant iron production in October totaled 564,697 tons as compared to 567,608 tons for the previous month, a decrease of only 2911 tons. The average daily production for October was 18,216 tons as compared to 18,920 tons for September, a loss of only 3.72 per cent. Merchant furnaces which were in blast during October and September showed a marked increase in production for the month just past. It is encouraging to note that the steel strike was supposed to be in full effect during October and had only started in September, and yet merchant iron production suffered only slightly.

Business Plentiful

At no time has the foundry business been more prosperous. Gray iron shops still lead inactivity and almost without exception are working to capacity. Malleable still is gaining with the prospect of the long expected railway orders which undoubtedly will follow closely after the return to private ownership. Steel shops are adapting themselves to wider varieties of castings and business is improved. Nonferrous foundries, almost without exception, are busy, especially those which are engaged in plumbing lines, or which make automobile appurtenances. Cast iron pipe shops are trying to catch up with the great demand from private sources, and preparing for anticipated municipal demand in the spring. Nonferrous prices based on New York follow: Copper, 20.00c to 20.50c; tin, 54.00c; antimony, 8.87½c; aluminum, No. 12 alloy, producers' price, 31.50c and open market, 29.00c to 30.50c. Zinc is quoted at 7.75c, St. Louis.

Comings and Goings of Foundrymen

ISAAC W. FRANK, president of the United Engineering & Foundry Co., Pittsburgh, retired from that position at the annual meeting of the company last week. Mr. Frank, however, will continue to serve in the capacity of chairman of the executive board. Florence C. Biggert Jr., for several years past chief engineer and second vice president of the company, succeeds Mr. Frank. William Gardner, manager of sales of the rolls department, has been chosen second vice president, succeeding Mr. Biggert. Charles H. Booth, of the Lloyd Booth Co. department, Youngstown, O., retired from the board of directors of the company, his place being filled by the election of John Quinn, manager of the American Roll & Foundry Co. department, Canton, O. Other officers and directors of the company were re-elected. Mr. Frank's retirement from active direction of the company is founded upon a desire for more leisure and an opportunity for travel. He expects to devote the next year to travel. Mr. Frank was one of the organizers of the United Engineering & Foundry Co., having been previously part owner of the Frank-Kneeland Machine Co., one of the United's associated companies. He was elected president of the company at its organization, July 1, 1901, and served in that position continuously until his retirement. He is a graduate of the Rensselaer Polytechnic institute, Troy, N. Y.; has been active in business and civil affairs in Pittsburgh, and was prominent in the National Foundries and Metal Trades association, of which he is a former president. He is a member of the American Iron and Steel institute.

ISAAC W. FRANK

H. L. Mote has been placed in charge of the recently opened New York offices of the Chesapeake Iron Works, in the Woolworth building.

W. Livingstone Newlands and Ernest Jennings have assumed charge of the foundry of the James Howden & Co. of America, Inc., Wellsville, N. Y.

A. K. Barr, formerly of North Andover, Mass., has opened a wood and metal pattern shop in North Chicago, Ill., under the name of the Barr Pattern Co.

Joseph Prendergast, who was discharged from the service in June, 1919, has been appointed general foreman in the foundry of the New England Steel Casting Co., East Longmeadow, Mass.

C. K. Sheridan became purchasing agent on Nov. 1 at Cleveland for M. A. Hanna & Co., Leader-News building, sales agents for iron ore, pig iron, coal and coke. He succeeds T. F. Cadden.

O. K. Carpenter, who had been connected with the Bayonne Steel Casting Co., Bayonne, N. J., for about six years, recently was made superintendent of the Millbury Steel Foundry Co., Millbury, Mass.

Eugene L. Bunting, salesman for the Buckeye Products Co., Cincinnati, O., has severed his connection with that company to accept the position of foundry superintendent with the Lunkenheimer Co., Cincinnati, manufatcurer of engineering specialties.

Leonard Crooke, who in the past has been connected with the H. Koppers Co., Pittsburgh, the Lackawanna Steel Co., Buffalo, and the Central Iron & Coal Co., Holt, Ala., has been appointed general manager of the Montgomery Coal Washing & Mfg. Co., Birmingham, Ala.

W. E. Banott, formerly with the American Rolling Mill Co., Middletown, O., has accepted a position with the West Michigan Steel Foundry Co., Muskegon, Mich., as manager of sales and assistant to the general manager. Mr. McKeon also has resigned his position with the American Rolling Mill Co. to accept that of second vice president and general manager of the West Michigan Steel Foundry Co., Muskegon, Mich.

Albert Hron, formerly with the West Bend Aluminum Co., West Bend, Wis., has accepted a position as works manager with the Kewaskum Aluminum Co., which has recently been organized by local interests at Kewaskum, Wis.

Lewis P. Smith has been placed in charge of the new office established in New York City by Matthew Addy & Co., Cincinnati. He formerly was in the Philadelphia and Cincinnati offices of the company and during the war served in the pig iron division of the war industries board. Mr. Smith will handle the sale of pig iron, coal, coke, ferroalloys, fluorspar, etc., in the New York and New England territories.

FLORENCE C. BIGGERT, JR.

Florence C. Biggert Jr., the new president of the United Engineering & Foundry Co., was born in Crafton, Pa., about 43 years ago and is a member of one of the oldest families of Pittsburgh. He was graduated from the University of Pittsburgh with the degree of mechanical engineer in 1899 and that fall entered the employ of the company as a draftsman and subsequently advanced to the position of assistant chief engineer. He succeeded Frank I. Ellis as chief engineer when the latter resigned. For the past few years Mr. Biggert has been second vice president of the company. He took a prominent part in designing and building the rail and billet mills at Gary, Ind.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

Hillis & Sons, Hollis street, Halifax, N. S., are having plans prepared for the erection of a foundry.

Erection of a foundry, 60 x 225 feet, is contemplated by the Pfau Mfg. Co., Cincinnati.

Erection of an addition to the plant of the Detroit Vapor Stove Co., Detroit, is being planned.

The capital stock of the Aetna Steel Castings Co., Cleveland, is increased from $79,000 to $300,000.

James Nute, Kennett Square, Pa., is reported contemplating the erection of a foundry.

The East Akron Castings Co., Akron, O., has increased its capital from $25,000 to $90,000.

Contracts have been awarded for the erection of a foundry for the James Mfg. Co., Ft. Atkinson, Wis. The building will be 400 x 600 feet.

The Anderson Foundry & Machine Works, Anderson, Ind., W. N. Durkin, president, is planning the erection of a plant, 80 x 200 feet.

The plant of the Quincy Engine Co., Chambersburg, Pa., has been leased by the Southwark Foundry & Machine Co., Philadelphia.

Charles E. Long and others of Lancaster, Pa., recently incorporated the Lancaster Foundry Works. The company is capitalized at $150,000.

A plant will be established at St. Boniface, Man., by the Western Steel & Foundries Co., a subsidiary of the Dominion Wheel & Foundries, Ltd.

Contracts have been awarded by the Co-Operative Foundry Co., Rochester, N. Y., for the erection of a plant addition.

Plans have been prepared for the erection of a foundry, 80 x 300 feet, for the Taplin-Rice-Clerkin Co., Akron, O.

Plans are being drawn for the erection of a foundry for the Bayer Steam Soot Blower Co., 2828 South LaSalle street, St. Louis.

The A. J. Detlaff Co., Detroit, has purchased 39 acres as a site for a new plant, which will include a gray iron foundry and a malleable castings plant.

The American Bridge Co. has been awarded the contract to erect an addition to the plant of the Stroh Castings Co., Detroit.

The Prentiss-Wabers Mfg. Co., Grand Rapids, Mich., has been reincorporated as the Prentiss-Wabers Stove Co., with a capital stock of $60,000.

Contracts have been awarded for the erection of an addition to the plant of the Rhode Island Malleable Iron Works, Pawtucket, R. I.

The Bridge & Beach Mfg. Co., Second and Valentine streets, St. Louis, manufacturer of stoves, contemplates the erection of a plant.

The Raith Construction Co., Philadelphia, has a contract to erect a foundry at 628 North Howard street, for the Wright Mfg. Co.

The capital stock of the Bristol Brass Co., Bristol, Conn., has been increased and the company plans the erection of plant additions.

Crompton & Knowles, Providence, R. I., loom manufacturers, contemplate the erection of a foundry, 83 x 222 feet.

Work is expected to be started soon on the erection of a foundry, 154 x 243 feet, for the Pettibone Mullekin Co., 140 South Dearborn street, Chicago.

The Josiah Anstice Co., Inc., North Water street, Rochester, N. Y., has awarded a contract for the erection of a foundry, 145 x 216 feet.

The Advance Stove Works, Evansville, Ind., is having plans prepared for the erection of an addition to its plant.

The Macbeth Evans Glass Co., Bethaven, Ind., care of Thomas Evans, has awarded contracts for the erection of pattern and machine shop additions.

The Hills, McCanna Co., 153 West Kinzie street, Chicago, manufacturer of brass and aluminum castings, recently acquired a plant at 2025 Elston avenue, Chicago, which affords ample space for the expansion of its machine shop and foundry.

The Jewell Steel & Malleable Co., 373 Hertel avenue, is having plans prepared for the erection of an addition to its foundry.

The Whitcomb Pattern Co., Lynn, Mass., recently was incorporated with $10,000 capital, by Fred L. Foster, Albert E. Simpson and John T. Garner.

The Utica General Jobbing Foundry, Utica, N. Y., recently was incorporated with $25,000 capital, by F. Longo, G. Buccolo and J. Tomaino.

The capital stock of the Clayville Foundry & Machine Co., New York, recently was authorized to be increased from $5000 to $50,000.

The capital stock of the H. S. Lee Foundry & Machine Co., Plymouth, Mich., recently was increased from $25,000 to $50,000.

Plans are being prepared for the erection of an addition to the plant of the King Foundry Co., St. Joseph, Mo. O. M. King is president of the company.

The Gas Traction Foundry Co., St. Paul, recently changed its name to the Northwestern Steel & Iron Corp., and increased its capital from $100,000 to $200,000.

Plans have been drawn for the erection of an addition to the foundry of the Cincinnati Steel Castings Co., 1218 Queen City avenue, Cincinnati. The building will be 47 x 90 feet.

Architect C. H. Kavieff, 712 Empire building, Detroit, is preparing plans for the erection of a foundry, 62 x 106 feet. The name of the owner has been withheld.

Among the recent incorporations noted is that of the Muskegon Aluminum Foundry, Muskegon, Mich. The company, which is capitalized at $75,000, was incorporated by Axel E. Johnson and others.

The Mohonoy City Foundry & Machine Works, Mohonoy City, Pa., recently was incorporated with $25,000 capital, by L. Garfinkel, M. J. Ryan and S. Fogel.

The Springfield Aluminum Plate & Castings Co., Springfield, O., has been organized to manufacture aluminum castings, etc., by William Jordan and others.

A 21-acre site has been purchased at Biddeford, Me., by the Saco-Lowell Co., on which it plans the erection of a modern foundry and other buildings. Construction is expected to start soon.

The Tilly Brass Mfg. Co., 145 Llewellyn street, Los Angeles, is being formed to manufacture brass products by Norman Tilly, 2670 North Sichel street, and others.

Capitalized at $60,000, the Perfection Machine & Castings Co., Michigan City, Ind., recently was incorporated to operate a foundry by Adolph Sorge, Edward M. Phillips and George A. Giles.

Contracts have been awarded by the General Electric Co., Schnectady, N. Y., for the erection of a brass foundry, 100 x 100 feet. The general contract was awarded to the H. K. Ferguson Co., Cleveland.

The Parkersburg Rig & Reel Co., 626 Marietta avenue, Parkersburg, W. Va., has awrded the general contract for the erection of a foundry. John Crawford is president of the company.

Improvements and the installation of a large cupola have been completed at the plant of the Wabash Foundry Co., Wabash, Ind., manufacturer of gray iron castings.

The Franklin Foundry & Machine Co., Providence, R. I., contemplates the erection of an addition to its foundry. O. D. Purington & Co., Providence, has the contract.

A concrete building to give about 25,000 square feet of additional floor space for the manufacture of foundry equipment, is being erected for the Union Metal Mfg. Co., Canton, O.

For the purpose of increasing its output of marine motors, the Gilmore Marine Motor Corp., Detroit, recently filed articles of incorporation. The firm has added a brass and iron foundry to its plant.

The Lockport Foundries Corp., Lockport, N. Y., recently was incorporated with $210,000 capital, by G. B. Stockwell, W. W. Campbell and J. W. Townsend.

A shop addition to be used as a core room, will be erected by the Atlas Foundry Co., Thirty-eighth and Burnham streets, Milwaukee. The building will be 80 x 88 feet.

Among the recent incorporations is that of the Northern Bronze & Castings Co., Cleveland. The company, which is capitalized at $10,000, was incorporated by S. Schwartz, American Trust building, A. V. Tablett and others.

The Globe Foundry Co., Sheboygan, Wis., which was incorporated recently, has increased its capital from $100,000 to $200,000. Architect W. C. Weeks is preparing plans for the erection of a main shop, 100 x 128 feet and a cupola building, 70 x 150 feet.

The Canton-Detroit Foundry Co., Canton, O., which was recently incorporated with $50,000 capital, has purchased the plant of the F. B. Widder Foundry Co., which it will remodel for the manufacture of steel castings for the automobile trade.

A recent incorporation is that of the Accurate Brass Casting Co., New York. The company, which is capitalized at $50,000, was incorporated by A. J. Gutmuller, L. J. Schukel and M. G. Knorr, 1116 Wyckoff avenue.

The Superior Brass Foundry Co., Milwaukee, which was recently incorporated with $50,000 capital, by Philip Loeher, Frank Schedler and H. H. Wheeler, has taken over a shop building at 282 Lapham street, and is converting it into a brass and bronze casting shop.

Ground has been broken at Watervliet, N. Y., for a new plant for the Troy Foundry & Machine Co., Inc., Troy, N. Y., successor to the West Side Foundry Co. The plant will be located on a 25-acre site and is expected to be ready about Jan. 1. John T. Starkweather is vice president and general works manager of the company.

An addition to the shop of the Newton Machine Tool Works, Inc., Philadelphia, is under construction. The new plant will cover a ground space, 230 x 400 feet. It will include an erection shop, a pattern and storage shop, forge shop and power plant. The plant will be equipped with two 50-foot span overhead traveling cranes.

The New Process Castings Co. recently was granted a charter in Delaware. The company, which is capitalized at $100,000, was incorporated by John C. Bramer, James Smith and John Mellor, all of Pittsburgh. Plans of the company have not been announced.

As contemplated by the A. Garrison Foundry Co., Pittsburgh, its old foundry shortly will be replaced by a new one, which will be modern in every respect. One section, 95 x 100 feet, is already in operation and a section 95 x 120 feet is being added. When the second unit is completed, a third similar to the second, will be added, after the remaining portion of the old foundry is domelished.

Quantity production has been attained by the Great Lakes Malleable Co., Milwaukee, in its new plant on Reed street. The unloading of the first annealing oven was begun Oct. 2. So much business has been booked that practically all of the casting

capacity is required and the addition of a third annealing furnace probably will be made shortly. W. T. Hercher, formerly of the Chain Belt Co., is superintendent.

Erection of a foundry, 100 x 200 feet, to be devoted to the manufacture of gray iron castings, is planned by a company to be organized as the Haywood Foundry Co., at Indianapolis, as a subsidiary of the Haywood Tire & Equipment Co. The plant will be equipped in the most modern manner, with traveling crane and monorail delivery of material from the cupola to the side bays. Provision will be made for the installation of two cupolas, which will be served by a narrow gage railroad. The cupola charging floor will be provided with a sunken track upon which a transfer car will be operated. The core ovens will extend outside of the building, and these will include two night ovens, each provided with double tracks, allowing four cars to the oven, and one day oven with several doors opening from both sides. A site for the plant has been purchased, and actual construction is expected to be started shortly. Organizers of the company consist of the stockholders of the Haywood Tire & Equipment Co.

New Trade Publications

WELDING AND CUTTING.—Oxy-acetylene welding and cutting apparatus is described and illustrated in a leaflet being circulated by the Alexander Millburn Co., Baltimore. Brief descriptions of the equipment are given, accompanied by illustrations. The leaflet contains a pressure chart and other data.

BELT CONVEYORS.—Catalog No. 3, issued by the Barber-Greene Co., Aurora, Ill., describes and illustrates portable and stationary conveyors and self-feeding bucket loaders. Several types are described and fully illustrated. Some of the illustrations show the equipment in actual service.

DECARBONIZING OUTFIT.—A small 4-page leaflet has been published by the Davis-Bournonville Co., Jersey City, N. J., in which a brief description of an outfit for burning out carbon deposits in gas engine cylinders and how the operation is performed are given.

FURNACE INSULATION.—The Celite Products Co., New York, recently issued an interesting bulletin describing in detail, standard engineering practices in insulating various types of furnaces, such as annealing, heating, forging, malleable, gun, glass, etc. Several illustrations are given.

CRANES.—The Northern Engineering Works, Detroit, has published catalog No. 28, in which electric cranes, hand power cranes, electric hoists and air hoists are fully described and illustrated. The booklet contains condensed descriptions of the various equipment all of which are fully described.

POWER EQUIPMENT.—Catalog 44-A issued by the Ohio Blower Co., Cleveland, contains illustrations and description of steam power plant equipment, including steam traps, separators, exhaust heads, feed water heaters, flanges, gasoline oil separators, water level control valves and various steam specialties. All equipment is fully described, including specifications, and is illustrated.

VENTILATORS.—The Ohio Blower Co., Cleveland, has published the sixth edition of a booklet, describing and illustrating metal ventilators. The booklet is well illustrated, showing a number of actual installations and the descriptions contain data showing the ventilation requirements of plants and structures of all kinds. Specifications, etc., are given. The booklet is entitled, "The Gospel of Fresh Air."

ELECTRIC WELDING.—An illustrated booklet of 16-pages showing how the damaged German ships, which were taken over by the government, were repaired by the use of electric welding, recently was published by the Wilson Welding Repair Co., Ltd., New York. The illustrations show the methods pursued in repairing the damaged boilers, cylinders, steam engines, etc.

RECTANGULAR MAGNETS.—The Cutler-Hammer Mfg. Co., Milwaukee, recently published booklet J in which it describes and illustrates rectangular lifting magnets, designed for the handling of regular shapes in iron and steel, such as sheets, bars, billets, ingots, pipes, etc. The booklet contains a description of these magnets, as to their construction, etc., and illustrations showing them in actual use.

HEAT TREATMENT CHART.—An interesting contribution to the trade literature of the year is a cardboard steel heat-treatment chart which has been published by the W. S. Rockwell Co., New York. Besides the chart, tables showing degrees in centigrade, degrees in fahrenheit, data on specific heats and melting points, conversion table of equivalents, heat equivalents, etc., are given.

FOUNDRY SUPPLIES.—Small tools and supplies for foundry, factory and general mill use, are described and illustrated in a 62-page catalog recently published by the Liberty Supply Co., Philadelphia. Among the supplies described are chaplets, hinge tubes, stove door catches, foundry nails, wire nails, twisted steel gaggers, molders' bellows, brushes, brooms, rammers, mallets, goggles, general molders' tools, shovels, wheelbarrows, trucks, core oven cars, etc. All articles are illustrated and specifications and other data are given.

AIR HOISTS.—A variety of air hoists, both vertical and horizontal, are described and illustrated in a 24-page booklet recently published by the Whiting Foundry Equipment Co., Harvey, Ill. These hoists are of especial use in plants where the cost of electricity is prohibitive or where current is not available. Compressed air and hydropneumatic elevators are also described and illustrated in the booklet, which is filled with general information, illustrations and descriptive data.

ELECTRIC HOISTS.—The Northern Engineering Works, Detroit, has published a 16-page booklet in which its type "D" electric hoists are described and illustrated. In these hoists, the hoist gearing is of forged steel, annealed. Gears are enclosed. All hoists are equipped with two brakes. A limit stop automatically stops hook at top of lift. Bearings are of phosphor bronze and are automatically lubricated. Controllers are of the enclosed type. All parts are interchangeable, and easily accessible. Other data are given as well as numerous illustrations.

ELECTRIC FURNACE.—A standard electric furnace for melting brass is described and illustrated in a 16-page bulletin, recently published by the Electric Furnace Co., Alliance, O. In this furnace electrodes are not used as a heating medium, the only service which they serve being their use to carry current into the resistor trough which forms the heating element. Other data given include charging, melting and pouring, auxiliary mechanism and typical records. A number of actual installations are given among the illustrations.

DUST COLLECTOR.—Bulletin No. 1454, issued by the Allis-Chalmers Mfg. Co., Milwaukee, is devoted to a dust collector which the company manufactures. The equipment is the bag filter type, and according to the bulletin the collecting of dust is accomplished by filtering the air or fumes through cloth bags of special weave, which are automatically cleaned, discharging the residue into a hopper at the bottom of the machine. The collector consists of a number of annular compartments, each containing 12 bags. The operation of the dust collector is given, as well as its construction, capacity, horsepower requirements, maintenance, etc. The illustrations help to give the reader a comprehensive idea of the machine.

FIRE BRICK.—An attractive cloth-bound 56-page booklet is being circulated by John G. Stein & Co., Ltd., Bonnybridge, Scotland. The booklet contains views of the company's plants, miscellaneous weights and measures, sizes of bricks for circles of various radii, testimonials, etc. Pages 23 to 40 inclusive contain illustrations of the various types and sizes of bricks manufactured, such as squares, scones or splits, side arch or culvert, end arch, etc. One section of the booklet contains line drawings of gas retorts, blast furnaces, hot blast stoves, cupolas, open-hearth furnaces and gas producers, showing how and where the various brick are used.

BY-PRODUCT PLANTS.—A 68-page booklet, entitled, "By-Product Coke and Gas Plants," has been published by the Koppers Co., Pittsburgh. This booklet is one of the best contributions to trade literature published so far this year. A brief, but thorough history, of the development of the by-product coke oven is given and is followed by descriptions of the modern coke oven, regenerative gas ovens, combination coke and gas ovens, by-product recovery methods, ammonia concentrating plants, recovery and refining process, coal and coke handling systems, the utilization of coke oven gas, tar distillating plants and laboratory and research work. The booklet is profusely illustrated throughout with cuts of actual installations and is printed on heavy coated stock.

CONVERTERS.—Catalog No. 150, issued by the Whiting Foundry Equipment Co., Harvey, Ill., is devoted to illustrating and describing a side-blow converter. The shell of the converter is formed of heavy steel plates. The converter has a dished bottom, a removable top, and is supported on heavy cast-iron standards in which trunnions are pivoted. Journals are of large area and bearings are provided with removable caps and arranged for proper lubrication. A tipping mechanism is operated by electric motor and consists of three reductions of cut gearing. The blast is conveyed to the tuyere box through the trunnion opposite the one used for tipping. This is connected to the tuyere box by a cast-iron wind box. The tuyere box has a removable cover. Other data are given as well as specifications and illustrations of accessory equipment.

ELEVATORS.—A loose-leaf booklet has been published by the Warner Elevator Mfg. Co., Cincinnati, in which the various parts of elevators, which it manufactures, are described and illustrated. The traction engines, with which these elevators are operated, are the direct-connected type. The motor, worm gear, brake and traction sheave are mounted on a heavy cast-iron bed plate. All parts are interchangeable; the worm wheel, according to the booklet, is hobbed from a solid blank of phosphor bronze and is bolted to a cast-iron spider; the worm and worm shaft are machined from a solid forging of high carbon steel; the ball thrust bearing is mounted on the end of the worm shaft and the brake is applied by a heavy spiral spring. Other parts of the engine are described, as well as four types of motors and three types of cars. One page of the booklet is devoted to a description of a direct-current controller.

CUPOLAS.—Catalog 146, a 44-page booklet published by the Whiting Foundry Equipment Co., Harvey, Ill., is devoted to cupolas manufactured by the company. Design and construction are given, as well as other data, including a table of sizes and capacities and descriptions and illustrations of cupola accessories. These cupolas are of heavy construction. The supporting columns are curved to allow the bottom door to clear in dropping. The shell is made of steel plate. The joints of stacks open downward and on the outside. Two rows of tuyeres are provided, which are flaring in shape and admit the blast through a small area in the shell, which is expanded into a large horizontal opening inside the shell of the cupola. Other parts of the cupola are described, and the booklet is well illustrated. The catalog is divided into two sections, the second of which is devoted to mechanical charging equipment. In this section typical charging floor layouts are given with illustrations and general information pertaining to such equipment. Other foundry equipment is also described.